

COMBAT
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Research Survey No. 2

Toward Combined Arms Warfare:

A Survey of 20th-Century Tactics, Doctrine, and Organization

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August 1984

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Library of Congress Cataloging in Publication Data

House, Jonathan M. (Jonathan Mallory), 1950—
Toward combined arms warfare.

(Research survey / Combat Studies Institute; no. 2)
"August 1984."

Bibliography: p.

1. Tactics--History--20th century. 2. Armies--
Organization--History--20th century. 3. Military
art and science--History--20th century. I. Title.

II. Series: Research survey (U.S. Army Command and
General Staff College. Combat Studies Institute; no. 2)
U165.H8 1985 355.4'2 85-72

CONTENTS

Contents	iii
Figures.	iv
Maps	v
Introduction	1
Chapter One. Prologue to 1914	7
Chapter Two. World War I.	19
Chapter Three. The Interwar Period.	43
Chapter Four. World War II: The Axis Advance, 1939-1942. . .	79
Chapter Five. World War II: The Complexity of Total War, 1942-1945. . . .	105
Chapter Six. Combined Arms After 1945	141
Conclusion	181
Notes.	191
Bibliography	207

FIGURES

1. Type French and German Divisions, 1914.	10
2. Type British and Russian Divisions, 1914.	11
3. Trench System, World War I.	23
4. Type U.S. and German Divisions, 1918.	41
5. Type German Panzer Division, 1935	56
6. French Light Mechanized Division, 1934, and Armored Division, 1940	62
7. Soviet Mechanized Corps, December 1935, and Motorized Division, 1939	67
8. U.S. Triangular Infantry Division, June 1941.	74
9. British Armored and Infantry Divisions, 1942.	90
10. Schematic of Blitzkrieg Encirclement.	98
11. Soviet Tank Corps, 1942, and Tank Army, 1943.	101
12. Type U.S. Armored Division, March 1942 and September 1943.	109
13. Soviet Assault Group Formation.	124
14. Type Soviet Tank Division, 1947, and Mechanized Division, 1946/51.	143
15. Type U.S. Infantry and Armored Divisions, 1947.	148
16. U.S. Pentomic Infantry Division	156
17. Type U.S. Armored Division, ROAD, 1965-1983	159
18. 1st Cavalry Division (Airmobile), 1965.	163

MAPS

1. Battle of Cambrai, 20-30 November 1917.	30
2. Second Battle of Armageddon, 19-24 September 1918	38
3. The Maginot Line and the 1940 Campaign.	59
4. Khalkin-Gol, 10-31 August 1939.	70
5. Sidi Barrani, December 1940	92
6. Sidi Bou Zid - Kasserine Pass, February 1943.	120
7. Imphal-Kohima, March-April 1944	136
8. Task Force Dolvin, Anyang-ni, Korea, 5 February 1951. . .	151
9. Lam Son 719, February-March 1971.	166
10. 7th Armored Brigade at Abu Agheila, 1956.	175

INTRODUCTION

We have gotten into the fashion of talking of cavalry tactics, artillery tactics, and infantry tactics. This distinction is nothing but a mere abstraction. There is but one art, and that is the tactics of the combined arms. The tactics of a body of mounted troops composed of the three arms is subject to the same established principles as is that of a mixed force in which foot soldiers bulk largely. The only difference is one of mobility.

-Major Gerald Gilbert, British Army, 1907¹

The concept of "Combined Arms" has existed for centuries, but the nature of the combination and the organizational level at which it occurred have varied greatly. Prior to the seventeenth century, for example, there was often no need to combine infantry, artillery, and cavalry at the small-unit level. Each branch served a specific function on the battlefield, and only the senior commanders present needed to coordinate the effects of the different arms. In succeeding centuries, the general trend has been to combine the arms at progressively lower levels of organization. The concern of commanders has gone from coordinating the separate actions of separate arms, to gaining greater cooperation between them, and finally to combining their actions to maximize the effect of their various properties.

At the time that Gilbert made his plea, many officers paid lip service to "combined arms," but few understood the need to achieve such cooperation or combination between the branches at the small-unit level. Since then, twentieth century warfare and especially mechanized warfare have developed to the point at which some form of combined arms is essential for survival, let alone victory, on the battlefield. Yet the very complexity of this warfare leads to specialization in both training and maintenance, a specialization that is currently reflected in the formation of companies and battalions consisting of one or at most three different major weapons systems. A mechanized infantry battalion, for example, normally includes direct-fire infantry weapons, antitank weapons, and limited indirect-fire support in the form of mortars and grenade launchers. Such a battalion has little or no organic capability in the areas of armor, air defense, engineers, long-range indirect fire, or air support. A tank or artillery battalion is even more specialized and restricted in its equipment.

Although these units are task organized and cross attached for field operations, the demands of specialization, unit identity, and maintenance naturally cause many soldiers to concentrate on the use of one weapon or arm to defeat the corresponding weapon or arm of the enemy. Such a narrow view has frequently characterized professional soldiers, who wish naturally to conserve techniques that seem effective. This simplistic approach is perhaps less common among senior commanders and within infantry or reconnaissance (armored cavalry) units, where the different weapons are integrated on a more frequent basis than in some other organizations. Still, at least some tank crews train primarily to fight enemy tanks, tactical fighter units seek air superiority over enemy fighters, and engineers concentrate on enhancing the mobility of their own forces while impeding the mobility and countermobility efforts of enemy engineers. All of these tasks are essential for combat success, but none by itself will ensure proper interaction between the different arms and weapons. Indeed, almost by definition a particular arm or weapon system has most of the same strengths and weaknesses of its enemy counterpart, and thus may not provide the best means of defeating that enemy.

The very term "combined arms" often means different things to different people, or is left undefined and vague. As a minimum, however, this term includes at least three related elements:

1. The combined arms concept is the basic idea that different arms and weapons systems must be used in concert to maximize the survival and combat effectiveness of each other. The strengths of one system must be used to compensate for the weaknesses of others. Exactly which arms and weapons are included in this concept varies greatly between armies and over time. Today, however, the list of combined arms would include at least the following: infantry (mechanized, motorized, airborne, air assault, light, and special or unconventional operations forces), armor, cavalry/reconnaissance, artillery, antitank forces, air defense, combat engineers, attack helicopters, and some form of close air support. Under certain circumstances, this list may also include electronic warfare and, when authorized, nuclear and chemical fires. Beyond this basic list, all the combat support and service support elements are equally important if the force is to fight in a coordinated and sustained manner. In the interests of brevity, however, logistical aspects of combined arms will be discussed only briefly in this study.

2. Combined arms organization, at whatever level (company, battalion, brigade/regiment, etc.), brings these

different arms and weapons systems together for combat. This may include both fixed, peacetime tables of organization and ad hoc or task-organized combinations of elements in wartime.

3. Combined arms tactics and operations are the actual roles performed and techniques applied by these different arms and weapons in supporting each other once they have been organized into integrated teams. This is the area that is of most concern to professional soldiers, yet it is precisely this area where historical records and tactical manuals often neglect important details. Moreover, combined arms tactics and techniques at the level of battalion or below are the most difficult aspects about which to generalize historically, because they are most subject to frequent changes in technology.

A short study such as this cannot possibly consider all the complexities that these three elements bring to recent military history. What it can do is trace some recurring themes or problems in the recent conduct of combined arms warfare in the British, French, German, Soviet, and United States armies. At various times, each of these armies has led the world in the development of tactics and doctrine. For the period since 1948, the Israeli Defense Force (IDF) must be added to this list, because the Israeli experience has had a major influence on weapons and doctrine elsewhere. In particular, this paper will identify general trends in the development of tactical and organizational concepts for integrating the different arms and weapons systems at division level and below. This does not mean describing the thousands of minute changes that have occurred in divisional structure in these armies since the division became a fixed table of organization. Yet, the trends in terms of proportions of different arms and levels at which those arms were integrated can be illustrated with a limited number of line and block charts. Such trends should provide an historical framework and background for readers who are developing their own more detailed concepts of how to organize and employ the combined arms today.

This study is a tentative overview rather than an exhaustive analysis. My hope is that it will prompt others to develop or even contest the trends described in these pages, thereby advancing the study of a central issue in land combat.

Before proceeding to specific historical developments, some basic comments on the combined arms concept are in order. Most of these comments are self-evident, but they may assist readers in placing the following chapters into context.

In the abstract, tactical warfare may be considered as a combination of three elements: mobility, protection, and

offensive power.² Mobility means not only the ability to maneuver and concentrate forces over terrain, but also the ability to move men and units when exposed to the fire of the enemy. Mobility is not an absolute, but must be measured relative to the difficulty of the terrain and to the mobility of other friendly or enemy forces. For a combined arms team, the least mobile element may determine the mobility of the entire force. Without mobility, the principles of mass, maneuver, and offense cannot be applied, and surprise becomes very difficult. Protection means both security against enemy surprise attack and protection to allow offensive maneuver or defense on the battlefield. This battlefield protection may be accomplished by using terrain defilade and defensive fortifications, or by employing artificial means such as armor. Offensive or fire power is necessary in order to impose one's will on the enemy, to overcome his protection.

These three elements have interacted continuously throughout military history. In particular, the past century has been characterized by a vast increase in weapons power, an increase that can be overcome only with great difficulty by a carefully designed combination of protected mobility and other firepower. The most obvious example of this is the defensive system of World War I. That combination of firepower and protection had to be countered by close coordination of infantry (mobility), fire support (offensive power), and armor (which theoretically combined all three elements). Even this explanation of World War I is simplistic, but the three basic elements of mobility, protection, and offensive power are present in most tactical equations.

At a more practical level, these three elements are combined technically in the design and employment of individual weapons and tactically in the combination of different weapons and arms. The 1982 edition of Field Manual 100-5, Operations, divides the concept and practice of combined arms into two procedures: supplementary or reinforcing combined arms, and complementary combined arms. As the name implies, supplementary combined arms means increasing the effect of one weapons system or arm with the similar effects of other weapons and arms. For example, the effects of mortars and artillery may reinforce or supplement each other in an integrated fire plan. Engineers may enhance the protection of armored vehicles by digging in those vehicles with engineer equipment. Complementary combined arms, by contrast, have different effects or characteristics, so that together they pose a more complicated threat, a dilemma for the enemy. The defender may place a minefield so that it halts an enemy force at a point where observed artillery or antitank fires can attack that enemy as he clears the minefield. The defender has thus integrated the different weapons to provide a much greater effect

than any one by itself could achieve. The resulting dilemma forces the enemy to accept casualties while clearing the mines, or to seek a passage elsewhere.

It is not sufficient, however, to develop a doctrine for combining the different arms and services. In order to practice, refine, and employ this doctrine, at least five other elements are necessary. First, an army must design and procure weapons with the characteristics required by the doctrine and must stay abreast of technical changes that may invalidate or modify those weapons and doctrine.

Second, the doctrine must be effectively explained and disseminated to the commanders who are expected to use it. Third, the commanders must believe that the doctrine can be effective with the organizations, weapons, and troops available. Dissemination and acceptance are hampered by the fact that soldiers naturally rely on past experience, so that a colonel may unconsciously expect platoons to function as they did when he was a lieutenant, years or even decades before. Experience is a priceless asset to any army, but it naturally retards or distorts the application of changes in technology and doctrine that may render parts of that experience obsolete.

Fourth, in the eyes of the commander, his unit must have the training and morale to implement the doctrine. A recurring theme of this study will be that professional soldiers tend to overestimate the amount and quality of training necessary for the rank and file to perform effectively in war. There is no substitute for good training, but historically leaders with high standards have rejected or modified doctrine that their troops seemed incapable of executing. On the other hand, training may genuinely be an obstacle to a particular doctrine or organization. If company commanders are, on the average, capable of coordinating only eighty men and two types of weapons systems, it would be useless to design 170-man companies with ten different weapons systems. Training officers to handle these larger, more complex units may be prohibitively expensive in peacetime.

Finally, a combined arms system cannot work without effective command and control to integrate and direct that system. Indeed, factors that improve span of control, speed of decision making, and leadership ability can be as important as the weapons themselves.

Successful commanders throughout history have instinctively understood these requirements. One could argue that neither Gustavus Adolphus of Sweden, nor Frederick the Great of Prussia, nor Napoleon I of France actually developed major new doctrines

and weapons for the combined arms. What they did well was to procure weapons, understand and disseminate doctrine, train their troops, and apply the results in battle. With the larger armies and technical complexity of weapons in this century, it may be beyond the capability of a single leader to fulfill all these requirements. This possibility further complicates a military reality in which, since 1914, the combination of different arms has become essential for survival rather than optional for improved combat power. The process of developing and institutionalizing the combined arms concept, organization, and tactics in this century is the focus of this study.

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CHAPTER ONE

PROLOGUE TO 1914

In the 1690s, European armies developed and fielded the socket bayonet, a long spike-shaped blade that could be fixed on the end of a musket without obstructing the bore of the weapon during loading and firing.¹ This simple device allowed well-disciplined infantry to withstand horse cavalry charges without the aid of specialized weapons such as the pike. For the next 150 years, infantry units armed solely with smoothbore firearms and bayonets were the backbone of all Western armies. Skilled senior commanders understood how to coordinate this infantry with cavalry and with direct-fire smoothbore artillery, but such coordination was rarely important at the level of regiment or below, because these units were basically armed with a single type of weapon. The need to maximize the firepower of inaccurate smoothbore weapons led to extremely linear deployments on the battlefield. The infantry maneuvered into long formations of two or three ranks, with the artillery located between or slightly behind the infantry battalions. The limited effect of even such carefully arrayed firepower made it possible, if dangerous, for dense masses of cavalry and infantry to attack at a specific point and break the thin lines of the defender. Fire-support coordination was simple, because the infantry and artillery unit commanders had face-to-face contact or used hand signals to designate targets.

The fundamentals of weaponry, technology, and small-unit tactics were refined but remained basically unchanged until the mid-1800s. Stability made professional soldiers skeptical of innovations even when they came from serious students of tactics.

Technology and Manpower

During the period 1827-1870, the first of two waves of technological change in the nineteenth century revolutionized the battlefield. The most important innovation of this first wave was the development of rifled, breech-loading firearms. The muzzle-loading rifle with a bullet-shaped projectile initially replaced the smoothbore musket. Rifling and an improved seal between bullet and bore increased the velocity and accuracy of small arms fire out to an effective range of nearly 500 meters.² During the American Civil War of 1861-1865, dense infantry formations in daylight provided lucrative targets for defenders armed with rifles. Both sides learned to spread out into skirmish lines when attacking. Defenders, for their part, had to dig in to reduce their own vulnerability to the attackers' rifle fire.

The muzzle-loading rifles used by most soldiers during the Civil War were already obsolescent, the result of the Prussian Army's development of the breech-loading rifle.³ Unlike muzzle-loaders, breech-loaders could be reloaded in a prone position, allowing infantry to remain under cover while firing repeatedly. Soon fixed, metallic-cased ammunition made loading even faster. By the time of the Franco-Prussian War in 1870-1871, most armies had adopted breech-loading artillery as well as rifles.

The first wave of technological change also included the introduction of the railroad and the telegraph. These inventions greatly increased the speed of communication, mobilization, and troop movement at the strategic and operational levels. At the tactical level, though, troops still maneuvered on foot or on horseback.

The second wave of technological change came in the 1880s and 1890s. Smokeless gunpowder, magazine-fed repeating rifles, recoiling and quick-firing artillery, improved artillery fuzes, machine guns, and internal combustion engines appeared in rapid succession. With the exception of the engine, these developments all increased the volume, range, and accuracy of fire, placing the soldier in the open at a tremendous disadvantage compared to the soldier in prepared positions. General staffs were created to mobilize and deploy enormous armies using these new weapons. Although radiotelegraphs existed in the armies of 1914, the radio had not yet improved to the point where staffs could follow and direct events on the battlefield.

The cumulative effect of these two waves was to make cooperation and coordination between different units and arms absolutely essential. Anything less than total coordination in the attack might well result in defeat by defensive firepower. Conversely, an uncoordinated defense invited disaster.

The American Civil War and the Wars of German Unification (1864-1871) gave professional soldiers many opportunities to evaluate the first wave of technological change. That technology, in combination with an effective reserve component system, provided the tools of victory in Prussia's struggles to unite Germany. When World War I began, however, professional soldiers had not yet digested and agreed upon the effects of the second wave of change. As will be seen below, most tactical doctrines in 1914 showed a healthy respect for the effects of firepower, but such doctrines had not solved the resulting problems on the battlefield.

Quite apart from changes in weaponry, the Prussian example of large cadre and reservist forces overwhelming professional armies convinced other European governments that they must develop mass armies of reservists. European general staffs therefore produced elaborate plans to mobilize and deploy such reserves by railroad at the outbreak of war. As a result of these efforts, by 1900, Germany had only 545,000 men on active duty but a total wartime strength of 3,013,000; France had 544,450 men in peacetime and 4,660,000 in war; and Russia could mobilize over 4,000,000 from a peacetime strength of 896,000.⁴ In contrast, the British Army Expeditionary Force of 1914 consisted essentially of regulars and contained only a limited percentage of reservists who had previously served on active duty.

The Prussian reserve and militia (Landwehr) formations of the 1860s were successful partly because they were filled with the veterans of previous Prussian wars. By 1914, however, a long period of peace had deprived most armies of such experienced reservists. Every continental army had to develop its own system of reserve training and organization, and every army had to decide what percentage of reservists could be absorbed into an active duty unit on mobilization. Many officers distrusted the competence of their citizen-soldiers. The absence of reservists from regular army formations during most of the year meant that units were well below authorized wartime strength and were in effect skeleton formations, thus making realistic training for both officers and conscripts difficult.

Organization and Doctrine

Pre-1914 armies organized the different combat arms into divisions and corps that bore a superficial resemblance to those of today. The most obvious difference was the absence of the vehicles and electronics associated with modern combat. By the end of the Napoleonic Wars, European armies had accepted the division as the wartime unit for combining infantry and artillery, although most cavalry was concentrated into separate brigades, divisions, or even corps.⁵ As in so many other areas, the Prussian example had produced considerable agreement by 1914 on the basic organization of an infantry division. Most divisions contained twelve battalions of infantry, each with two machine guns either assigned or in direct support (see Figures 1 and 2).⁶ Battalions were usually grouped into four regiments and two brigades, although the British regimental headquarters no longer had a tactical command function and therefore remained in garrison. Divisional cavalry was universally very small, because most functions of screening and reconnaissance were assigned to the separate cavalry brigades or divisions. These large cavalry

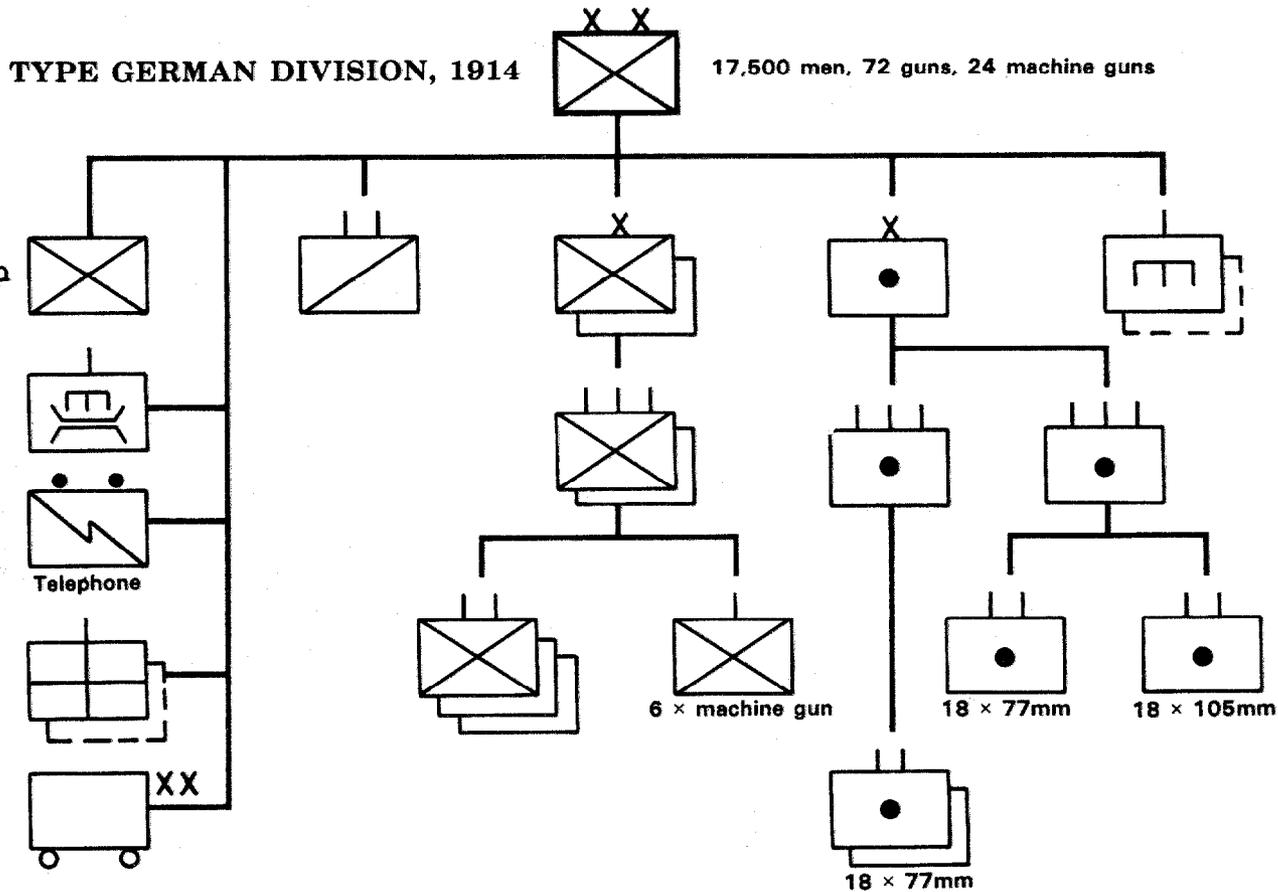
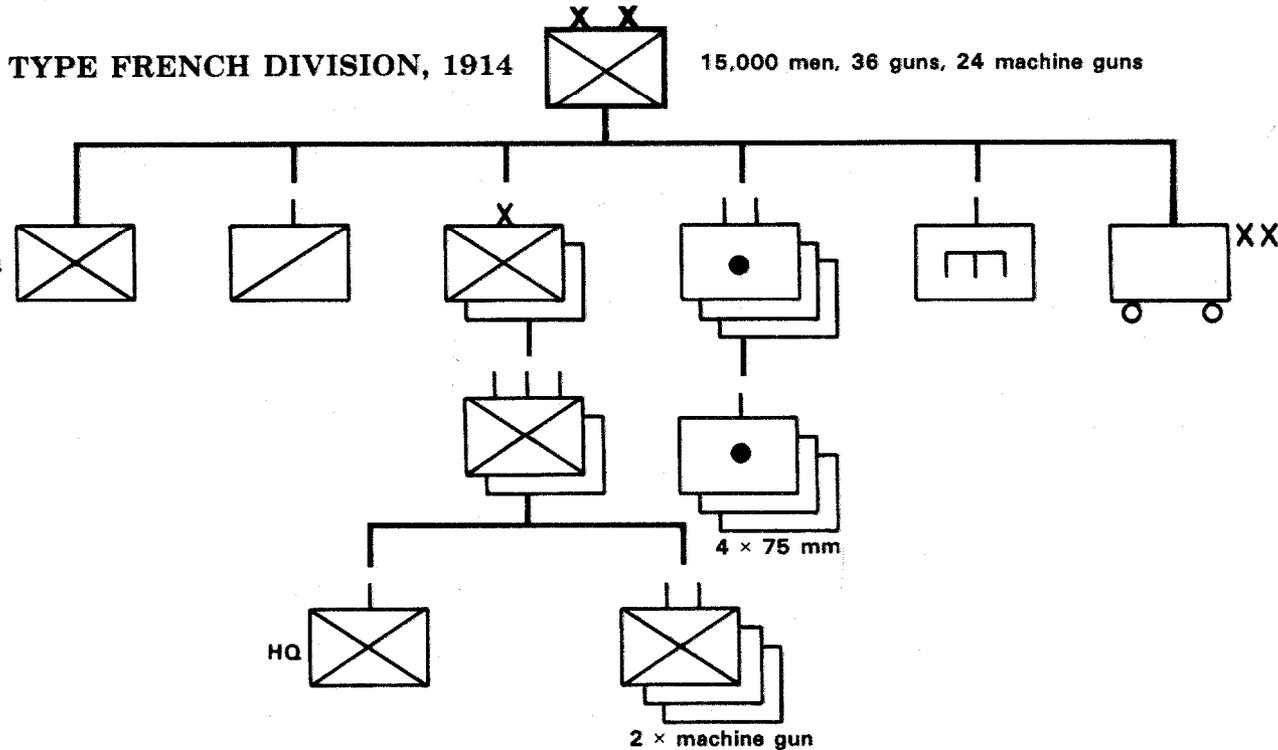


Figure 1. Type French and German Divisions, 1914

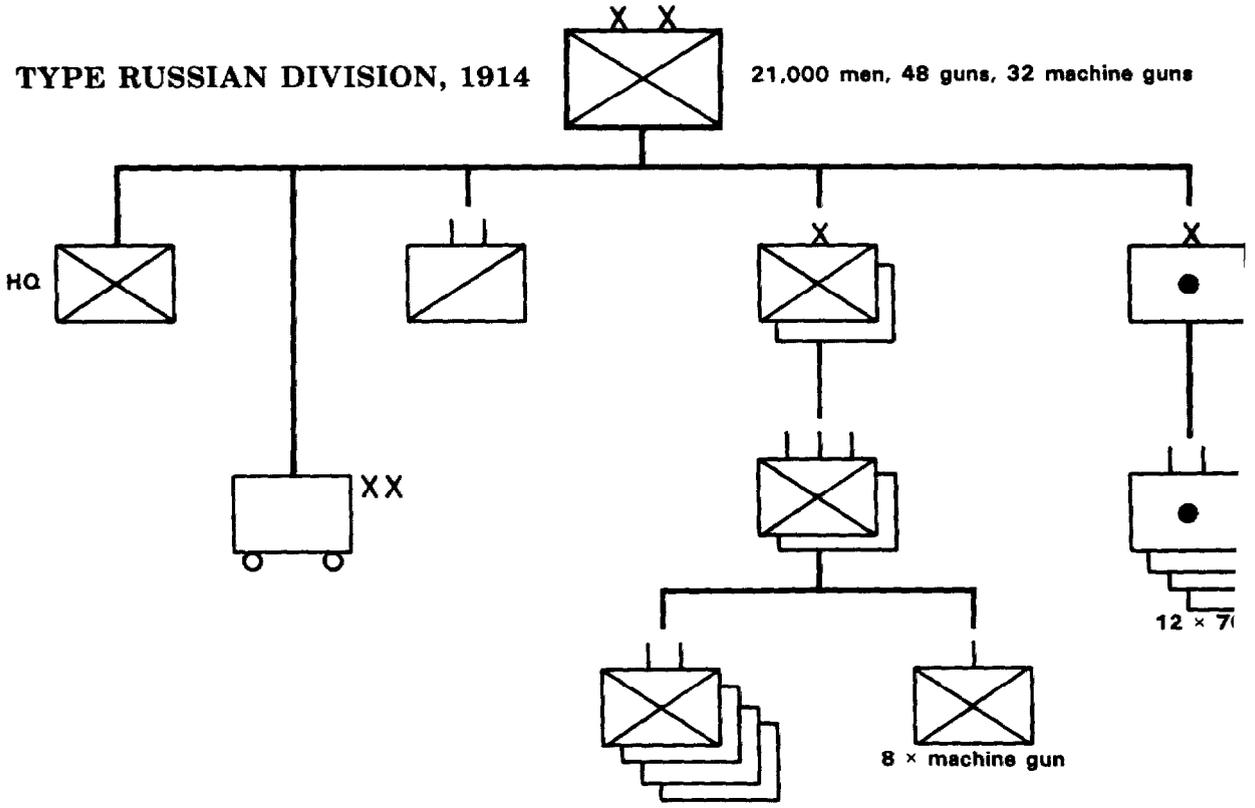
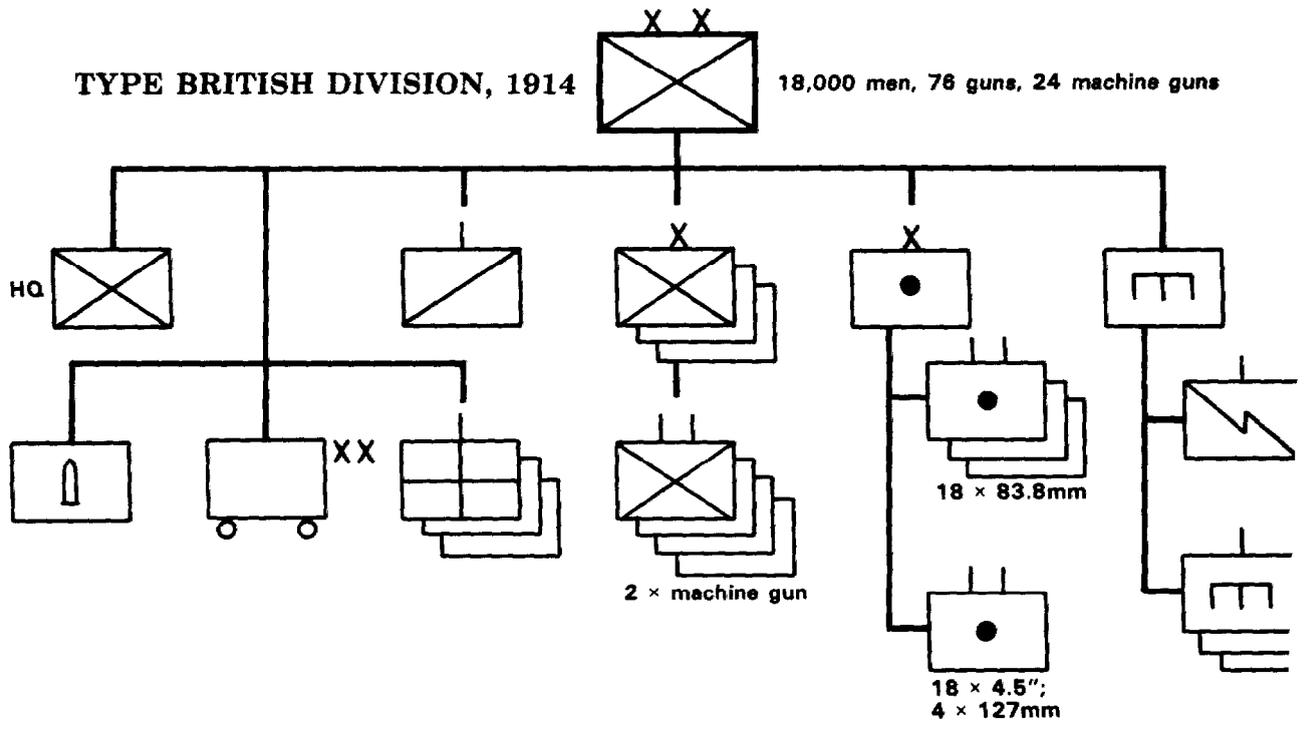


Figure 2. Type British and Russian Divisions, 1914.

formations were almost pure cavalry, with a few horse artillery batteries attached. Not until 1913-14, for example, did the Germans add company-sized elements of mounted engineers and bicycle-equipped infantry to their cavalry divisions.⁷

Where the armies differed most markedly was in the proportion and calibers of artillery included in the infantry divisions. Divisional artillery varied from as few as thirty-six light guns of 75-mm in the French division to as many as seventy-six artillery pieces, including eighteen 4.5-inch (114.5-mm) howitzers and four 127-mm guns, in the British division. These variations in structure reflected profound confusion and disagreement over the role of artillery and the importance of combined arms.

In order to understand the doctrinal interrelationships of the different arms before World War I, some consideration of each arm is in order. Cavalry and engineers may be discussed briefly; infantry and artillery deserve a more detailed explanation. Because the U.S. division was only just developing during the period 1911-17, it is omitted from this discussion.

Cavalry had the greatest mobility in the days before automobiles and was therefore closely associated with functions requiring such mobility. Traditionally, cavalry had three missions: reconnaissance and security before the battle, shock action on the battlefield, and pursuit after the battle. The increases in firepower during the later 1800s led many tacticians to suggest that shock action was no longer a feasible role except under rare circumstances. They argued that, because the charge seemed almost obsolete, cavalry should be reequipped as dragoons or mounted infantry. This would enable the mounted arm to continue its reconnaissance or security mission, while also functioning as highly mobile infantry that dismounted to fight after making contact with the enemy. Cavalry actually operated in this manner during the American Civil War, the Boer War (1899-1902), and the Russo-Japanese War (1904-05). By 1914, the British and German armies had equipped their cavalry with machine guns and trained them to fight dismounted when necessary.

Yet the desire to retain cavalry's operational mobility in reconnaissance, security, and pursuit caused many cavalrymen to prefer mounted fighting whenever possible, despite the large target a horse and rider presented to the enemy. Another factor, social conservatism, also helped preserve the traditional cavalry of lances and sabers in most armies. In addition, defenders of cavalry shock action justified their views by citing one cavalry charge of the Franco-Prussian War, an action appropriately known as "Von Bredow's death ride." At the battle of Vionville-Mars-la-Tour on 16 August 1870, Maj. Gen. von Bredow

led his Prussian cavalry brigade down a depression to within a few hundred meters of the left flank of the French VI Corps. The French had already suffered from artillery fire and were not entrenched when von Bredow charged out of the smoke. The charge achieved its objective. Yet during an attack that took less than five minutes and produced only a momentary tactical advantage, 380 out of 800 German cavalrymen were killed or wounded.⁸

Of the four combat arms, engineers were the most neglected in doctrine. They generally operated in very small units, performing technical tasks and maintaining weapons or equipment in addition to their mobility and countermobility missions. Because of these missions, engineers were often the only troops trained in the detailed construction and destruction of obstacles and field fortifications.⁹

With respect to infantry, a rifle battalion before 1914 was just that--four companies of rifle-armed infantry plus, in most cases, two heavy machine guns. Such battalions lacked the variety of grenades, mortars, and similar short-range, indirect-fire weapons that we today associate with "infantry." To some extent, armies neglected these weapons because of the specialized training they required, or because, in the case of the heavy machine gun and mortar, the pieces were too heavy to keep pace with advancing infantry. Machine guns were usually cast in an economy-of-force role, such as protecting an open flank. Moreover, once an infantry battalion detrained and advanced to contact, it was neither more mobile nor more protected than infantry in the eighteenth or nineteenth century. The firepower of breech-loading, magazine-fed rifles and machine guns had greatly outstripped the mobility and survivability of foot-mobile infantry. As everyone discovered in the fall of 1914, the only immediate remedy was to entrench. All professional soldiers were aware of this problem before the war, but they regarded defensive firepower as a costly obstacle that had to be overcome by a highly motivated attacker. Attacking infantry was expected to forego protection in order to maximize its own firepower and mobility.

In order to understand this belief, we must consider the war that professional soldiers expected to fight in 1914. The Wars of German Unification had provided models of short wars won by decisive offensive action. Over and over during the summer of 1870, the better-trained and better-armed French infantry had taken up carefully selected defensive positions, only to be outflanked and driven back by determined and costly German attacks.¹⁰ Thus, many soldiers concluded that standing on the defensive was a sure road to defeat. In any event, no one believed that a war that mobilized the entire manpower of a

nation could go on for more than a few months. War in 1914 meant that an entire economy halted while the reserves mobilized and fought. Under such circumstances, societies and economies would collapse if the war dragged on.

This belief in a short war determined many of the tactical expectations of European soldiers. With few exceptions, they did not anticipate assaulting prepared fortifications across open ground. Instead, most soldiers envisaged a series of meeting engagements or encounter battles.¹¹ Each commander hoped that his cavalry screen or his infantry advance guard would find a weak point which he would attack immediately to develop the situation, and force that enemy onto the defensive. The attacker's artillery would then act to pin down and isolate the enemy defender, preventing reinforcement or serious entrenchment.

Meanwhile, the attacking infantry would approach the hastily entrenched enemy, preferably by maneuvering to an open flank. The goal was to infiltrate to within 400-800 meters of the defender by using all available cover and concealment. During the Balkan Wars of 1912-13, Serbian and Bulgarian infantry had infiltrated to within 200 meters of the enemy before opening fire. Most soldiers considered this to be an exceptionally successful movement.¹² Once the defender engaged the advancing infantry, the attacker would deploy into a series of skirmish lines. The desired density of these skirmish lines varied between armies and over time, but soldiers generally moved one to three meters apart. Because of the recognized strength of the defender's firepower, skirmishers would advance by fire and movement, one group providing covering fire while another group rushed forward for a short distance. The size of each group and the distance covered at one rush would both become smaller as the attacker closed with his opponent. Enemy fire would intensify while the attacker found cover more sparse. Casualties were expected, but supporting troops would replenish the attacking skirmish line. The defender would be outnumbered and isolated. Prewar machine guns were too heavy to accompany the advancing skirmishers, so these guns were usually deployed to provide fire support from the rear. Eventually, the attacker expected to get within a short distance of the defender, establish fire superiority with infantry rifles, and assault with the bayonet.

With certain variations, most armies shared this doctrine before 1914. It had a number of problems that are obvious in retrospect, but were not so evident at the time. First, the attacker assumed that he would have local numerical superiority over the defender, whereas the numbers of troops fielded in 1914 were so similar that numerical superiority, even at specific points, was difficult to achieve. Second, this scenario assumed,

perhaps unconsciously, that the enemy and friendly forces were operating in a vacuum, moving to contact against each other with their flanks open for envelopment. In practice, however, the density of forces along the French, German, and Belgian frontiers in 1914 was so great that anyone seeking to maneuver to the flank was likely to encounter another unit, either friendly or enemy. Open flanks did occur, notably in the battles of the Marne and Tannenberg at the end of August, but these were exceptions caused by faulty command decisions on a battlefield that was still fluid.¹³

The most significant problem with prewar doctrine was that many professional soldiers considered their subordinates incapable of executing the tactics required. The kind of battle envisioned seemed to depend on two things: high morale and firm control. Officers, especially in the French, Austrian, and Russian armies, continually emphasized the psychological advantage of the attacker. Yet most professionals recognized that discipline and control would be extremely difficult to maintain under intense direct fire. The problem was compounded by the fact that, with the partial exceptions of the British and German armies, most European units had a large number of reservists and untrained draftees. A French first-line infantry company, for example, had a wartime authorized strength of 225 enlisted personnel, of which 65 percent were reservists or first-year conscripts.¹⁴ According to many observers of peacetime maneuvers, these reservists and conscripts demonstrated that they lacked the training and discipline necessary to conduct dispersed fire-and-movement tactics under heavy enemy fire. Professional soldiers argued that these troops would never stand up and advance if they were allowed to take cover. This belief, correct or not, led French, Russian, Austrian, and other officers to attack standing up in relatively dense formations. These officers recognized the risk they were taking, but felt that there was no other way to achieve the necessary rapid victory with undertrained personnel.¹⁵

Because the British Expeditionary Force of 1914 was a phenomenally well trained body of regulars and some reservists, the British did not face this training problem at the outbreak of war. The German Army minimized the same problem by a three-tiered system of units, consisting of twenty regular army corps with a relatively low proportion of well-trained recent reservists, fourteen reserve corps composed of regular cadres and large numbers of reservists, and numerous smaller Landwehr or militia formations. By carefully focusing on training before the war, the German Army not only reduced the problem in first-line units, but became the only European army to produce fairly effective reserve component units. Indeed, one of the great surprises for France in 1914 was the German willingness to use

these cadred formations in the line of battle immediately. Prewar French estimates of enemy strength had ignored these reserve units.¹⁶ Both the British and German armies, however, suffered heavy casualties in the initial campaigns. They had to form new divisions from half-trained, patriotic volunteers during the fall of 1914, and these volunteers were then used in rigid attacks that repeated the suicidal French tactics of August-September.

Given the emphasis in all armies on the meeting engagement and the hasty attack, prewar training often neglected the defense. The Germans constructed field fortifications for their annual maneuvers, but their defensive doctrine focused on rigidly holding a single, densely occupied trench. French defensive doctrine, as reflected in prewar engineer manuals, planned for a defense-in-depth, with an advanced position to delay the enemy, a main line of resistance, and a second position to limit a successful enemy penetration.¹⁷ Ironically, these doctrines had been reversed by 1915, with the French and British defending well forward in a rigid structure, while the Germans were beginning to develop a defense-in-depth.

If infantry had difficulty adjusting to the requirements of the new firepower, artillery was even slower to react. The traditional tactic for artillery, as perfected by Napoleon, was to concentrate the guns in a direct-fire role, placing them between or a few hundred meters behind the infantry units they were supporting. This tradition of direct-fire support meant that by 1914 all armies had standardized on relatively light, highly maneuverable field guns with flat trajectories, even after advances in technology had made accurate indirect fire possible. The French 75-mm, the German 77-mm, the American and Russian 3-inch (76.2-mm), and the British 18-pounder (83.8-mm) were all designed for this role. Larger weapons were too heavy for a standard team of six horses to move across country. These guns were too small to have much effect against even hasty field fortifications, and they lacked the high trajectory necessary for indirect fire in rough terrain. This was perfectly satisfactory to the French. In preparation for an infantry attack, French commanders relied upon an extremely rapid rate of direct fire to suppress temporarily, rather than to destroy, a defending enemy.¹⁸ The volume of such fire was intended to force the enemy to remain under cover, unable to provide effective aimed fire, even if he were not wounded by the French shells. The colonial wars of the nineteenth century had encouraged the British to believe in a similar suppressive function. That same experience had also led the British Army to maintain a much higher proportion of artillery than in French divisions, because British infantry had discovered the value of such fire

support.¹⁹ Artillerymen knew about indirect-fire techniques but rarely practiced them because they seemed complicated and unnecessary.

The Boer War, and even more the Russo-Japanese War, provided a glimpse into the future, with trench systems and the skillful use, particularly by the Japanese, of indirect-fire artillery. Many professional soldiers dismissed these conflicts as minor wars fought at the end of long supply lines and having no useful lessons for a future war in Europe. Yet observers of the Russo-Japanese War, especially those from the German Army and British Royal Artillery, were impressed with the necessity for indirect fire, if only to protect the gun crews from enemy counterbattery fire. The rest of the British Army, however, insisted upon having close direct-fire support and believed simplistically that massed firepower was accomplished only by massing guns well forward on the ground. Thus, the British in 1914 fell between two chairs: they possessed an assortment of weapons but no clear doctrine.²⁰ The German Army, by contrast, conducted a serious study of indirect-fire techniques and equipment. Beginning in 1909, the Germans increased their indirect-fire capability by converting one battalion in each division to 105-mm howitzers and by adding a battalion of 150-mm howitzers to each corps artillery. These weapons had an effective range of 7.5 kilometers, as opposed to the French 75-mm with a four kilometer range.²¹ By 1914, Germany had 3,500 medium and heavy pieces, including many howitzers and large siege mortars, while France had only 300 modern guns larger than 75-mm.²² A few of the German heavy weapons had been developed to reduce Belgian fortresses, but they were still available for field use.

The small caliber and limited number of guns involved in most of the lesser wars at the end of the 1800s meant that no one was prepared for the devastating effects of massed, large-caliber artillery fire on the battlefield. To complicate matters further, in the nine years between the Russo-Japanese War and the start of World War I, a final technological change occurred in the explosive charges contained in artillery rounds. The experiments of Alfred Nobel and others gave all armies high explosive rounds that were much more destructive than the artillery shells of the nineteenth century.²³

Thus, at the outbreak of World War I, cavalry and artillery in most armies had not fully adjusted to the new technology, while infantry commanders doubted their ability to execute the relatively sophisticated fire-and-movement tactics of the day. Perhaps most significantly, none of the combat arms had trained for really close cooperation with the others, an oversight that

proved disastrous in 1914. The most obvious example of this mind-set was the standard method of describing the size of an army in the field. Instead of counting combined arms divisions, or even single arm regiments, the average professional officer described any force in terms of the numbers of rifles, sabers, and guns--the separate weapons of the three principal arms.

CHAPTER TWO

WORLD WAR I

The defensive power of indirect artillery and machine guns dominated the battlefields of 1914. From the very first contacts, commanders had to restrain the "impetuosity" of their troops and insist upon careful engineer preparation in the defense and artillery preparation in the offense.¹ The French and British were shocked by the vulnerability of their exposed troops and guns to carefully sited German machine guns and artillery. The Germans, in turn, were surprised by the accuracy and rapidity of British and French guns. By the end of 1914, this firepower had resulted in the creation of a continuous line of foxholes and hasty trenches from Switzerland to the North Sea. Thereafter, every attack was of necessity a frontal attack on these trenches.

The stereotype of trench warfare did not appear overnight. On both the Eastern and Western fronts, the battles of August-September 1914 were characterized by a great deal of fluidity and maneuver. Prewar infantry tactics appeared to work under the right circumstances. At 0430 on 8 September, for example, the infantry of the Prussian Guard Corps infiltrated forward and, in a surprise attack without artillery preparation, overran the positions of the French XI Corps.² On the Eastern Front, the German Eighth Army surrounded and destroyed an entire Russian army by a double envelopment. In fact, the Eastern Front was never as immobile as the Western, because of the greater frontages involved. Yet, this fluidity produced indecisive results until first the Russians and then the Austro-Hungarians became exhausted and demoralized by attrition.

Given these examples of maneuver, many commanders regarded the thin line of 1914 entrenchments as an unnatural and temporary pause in the war. British and French commanders spent most of the war seeking the means of penetrating and disrupting the enemy defenses in order to restore the war of maneuver. Because the Germans concentrated most of their efforts on the Eastern Front during 1914-1916, they conducted an economy-of-force defense with relatively few attacks in the West. In order to understand the nature of World War I tactics, therefore, we need to examine the problems of Allied attacks and, then, the development of German defensive doctrine. The solutions to both problems involved greater cooperation than had previously been established on either side; in some cases they also involved the combination of the different arms.

Artillery and Coordination

Once the infantry attacks failed and trench warfare became the reality of combat, the most obvious means of creating a penetration was massed artillery fire. Indeed, the British and French rapidly gave up any idea of combining artillery fire with infantry maneuver and concentrated instead on achieving overwhelming destruction in the preparatory fires. Although higher-level planners still saw a role for infantry, many tactical commanders interpreted the new techniques as "the artillery conquers, the infantry occupies."³

Artillery conquest was not easy. Everyone had expected a short war, and thus few armies had sufficient supplies of ammunition and heavy artillery to conduct the massive preparations necessary to demolish even temporary field fortifications. In both Britain and Russia, scandals arose over the long delays necessary to produce more ammunition and guns. Even when France began to produce more guns, the first models of medium and heavy artillery had extremely slow rates of fire, while the more rapid 75-mm gun had such a short range that it had to move well forward and displace frequently behind the advancing troops in order to destroy any defenses-in-depth.⁴

Adding to the problem was the fact that most gunners had little experience in precision indirect fire. Many of the procedures that are commonplace to artillerymen today were developed painfully during the period 1914-1917: establishing forward observer techniques, measuring and compensating for the effects of weather and worn barrels, and using ammunition from the same production lot to ensure that successive volleys fell in the same general area. The first French regulation describing such procedures was not published until November 1915. The British Royal Artillery needed new maps of the entire area of Northeastern France before it could establish a grid system for surveying battery locations and adjusting indirect fire. The fledgling air services of the belligerents had to provide aircraft for photographic mapping and both aircraft and balloons for adjusting indirect fire. Finally, improved radiotelegraphs allowed aerial observers to talk to the artillery fire controllers.⁵ Such developments took most of the war to reach perfection.

Quite apart from the technical problems of indirect fire, there was the even greater problem of coordinating the infantry and artillery in an attack. The first deliberate attacks conducted by the British and French during late 1914 and early 1915 were particularly difficult to control, because both artillerymen and commanders lacked experience in indirect fire. The easiest procedure seemed to be the establishment of a series

of phase lines, with artillery firing on the far side of a phase line while all infantry remained on the friendly side. Once the commander directed artillery fires to shift forward past a new phase line, the troops could advance in relative safety.

Such phase lines encouraged commanders to ignore the terrain contours to their front and the possibilities for maneuver, and to favor instead simple advances by all units on line. This in turn discouraged massing of artillery or infantry at critical points. More importantly, there were no effective communications procedures that would allow the leading infantry units to talk to their supporting artillery. During the Champagne campaign of 1915, the French went to the extreme of sewing white cloths on the backs of their soldiers to help observers determine the forward progress of troops, but casualties from friendly fire still occurred. The Germans experimented with colored flares and signal lamps to communicate between infantry and artillery, but such signals were often difficult to recognize amidst the destruction of battle.⁶

Beginning with the battle of the Somme in July 1916, artillery was able to provide a rolling barrage of shrapnel that could advance at a steady rate of speed. The use of shrapnel instead of high explosive made it safer for the infantry to advance close behind the artillery barrage (about 100 meters), because the explosive effect of shrapnel was focused forward along the line of flight. Shrapnel, however, had almost no effect against well-prepared positions--the best it could do was force the defender to stay under cover during the assault. In addition, there was still no way for the infantry to adjust the rate at which the rolling barrage moved forward. The rigid forward movement of artillery fire often outran the heavily laden infantryman struggling across the shell-pocked battlefield, allowing the defender time to leave his shelter and engage the attacker after the barrage had passed over a trench.

This problem of infantry-artillery coordination was only one aspect of the greater problems of command, control, and communications that plagued a World War I commander. The huge scope of offensives and the scarcity of trained staff officers at junior headquarters meant that most operations were planned at the level of field army or higher. Given the crude nature of artillery procedures in the early stage of the war, artillery planning and control were also centralized at a high level. This meant that each time the advancing infantry reached an objective or phase line they had to stop and request permission to continue the advance or to commit reserves. A messenger had to hand-carry the request under fire back to the lowest headquarters (usually brigade, regiment, or division) where the field telephone circuits had survived enemy counterfire. These circuits then

relayed the request through the different levels of headquarters in order to obtain a decision from the senior commander in charge of operations. Once a staff estimate had been made and the commander's decision announced, this communications process had to operate in reverse before the troops could advance. For example, at the battle of Neuve Chapelle on 10 March 1915, one of the first concentrated artillery preparations of the war destroyed most of the shallow German defenses. The forward British troops, however, had to wait at a phase line for seven hours before they received authorization from their corps commanders to continue the advance. During this delay, the Germans were able to move in reserves and reestablish a defense in the very path of the British advance.⁷ Once the momentum of an attack was lost, it was very difficult to organize a renewed advance.

To some extent, these communications problems were a product of the technology of the time. A senior commander could not command close to the front even if he wished to. He was tied to the field telephone system that brought all information to him and conducted all orders forward. Although radios did exist, they were bulky, unreliable, and generally suspect because of the possibility of enemy signals intelligence. These limitations, plus the difficulty of direct communication between infantry and artillery, made subordinate initiative and rapid exploitation potentially disastrous. The attacking troops might well fall prey to their own artillery support if they did not coordinate with higher headquarters.

By 1918, improvements in artillery techniques and communications made such initiative much more practical. The Australian general Sir John Monash, for example, developed an elaborate system to determine the forward progress of his forces. Advancing troops carried specially colored flares, while a detachment of aircraft did nothing but spot the location of these flares, write out reports based on the locations, and airdrop the results to Monash's headquarters. This gave a corps commander the forward trace of his forces with a delay of twenty or fewer minutes, provided he had local air superiority.⁸

The Problem of Penetration

The problems of indirect artillery fire and of command and control were only two aspects of the basic tactical question of how to achieve and exploit a penetration more rapidly than the defender could redeploy to prevent or seal off a penetration.

Consider the accompanying abstract diagram (Figure 3) of a fully developed trench system. In order to advance, one side had to begin by neutralizing the defensive fire of the enemy's

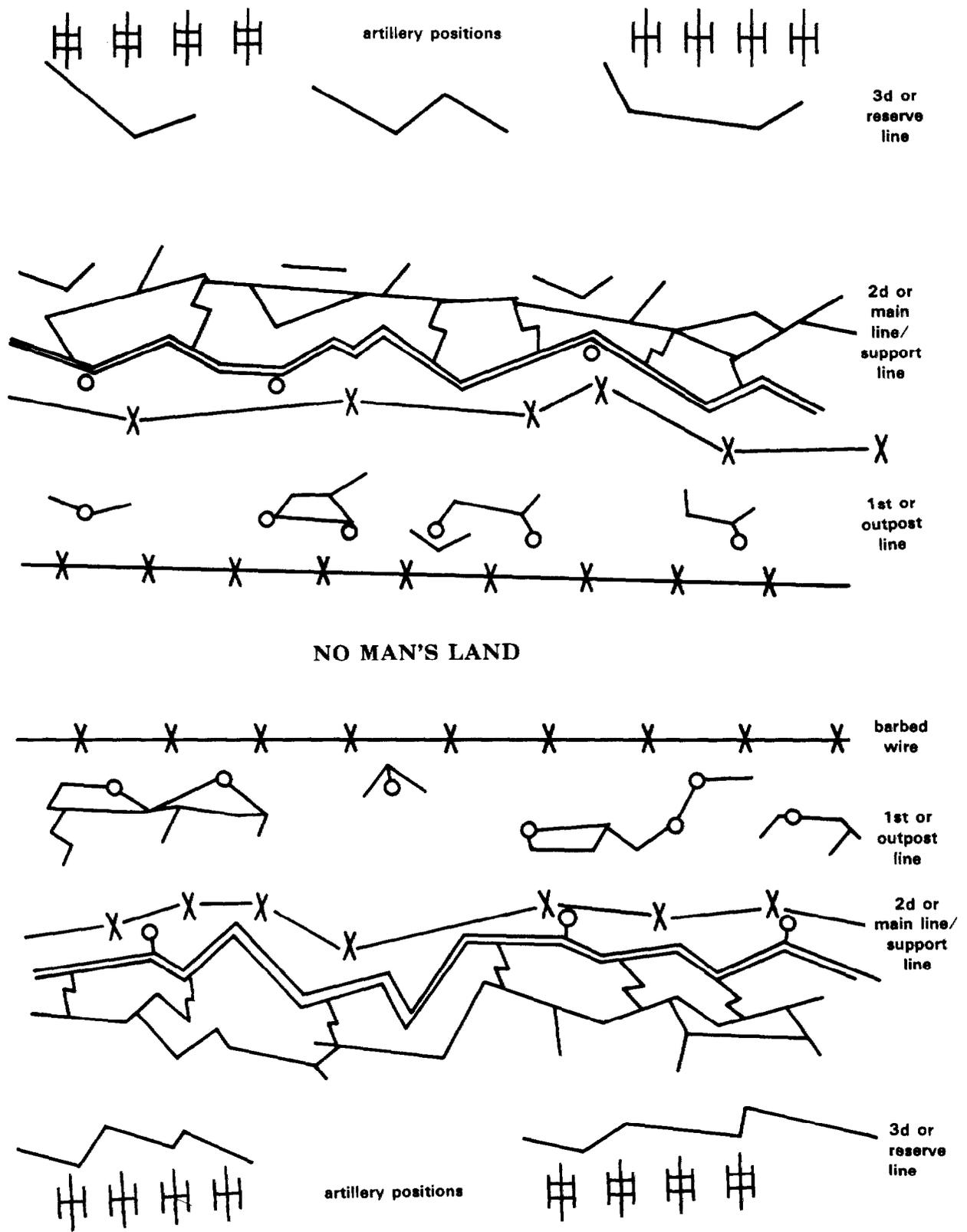


Figure 3. Trench System, World War I.

trenches and artillery batteries. As early as the battle of Neuve Chapelle in 1915, the British had demonstrated the possibility of achieving such a penetration by concentrated or prolonged artillery fire. Eliminating the barbed wire and similar obstacles in front of the enemy trenches was somewhat more difficult. Shrapnel had very little effect against wire; nor would prewar fuzes for high explosive rounds detonate against the very slight resistance they encountered when passing through barbed wire. By 1917 the British had developed the instantaneous model 106 fuze that would detonate high explosive rapidly enough to destroy wire.⁹ Indeed, even the Germans conceded that artillery and infantry together could always capture the first and even the second trench lines, especially if a short artillery bombardment and good operational security maintained surprise.

The problem came when the attacker tried to displace forward to develop and exploit the resulting partial penetration. The infantry that had made the initial assault would be exhausted and in many cases decimated, while the artillery would need to move forward in order to continue its fires on the enemy third line and artillery positions. Even after a senior commander learned of success, decided to exploit, and communicated his decision forward, all of his troops, guns, and supplies had to move across the intervening No Man's Land and captured enemy trenches, an area that usually was a sea of mud and shellholes. In most cases, by the time the attacker had completed this displacement, the defender had been able to bring up reserves and establish new trench lines in front of the attacker. The defender's role was much easier, because his reserves could move by railroad and motor truck while the attacker's forces toiled forward over the broken ground. Moreover, the defender could easily counterattack and pinch off any penetration that did not occur on a broad frontage, because the newly captured area would be exposed to concentrated defensive artillery fire.

Even if the attacker moved faster than the defender and actually penetrated through existing trenches and gun positions, the second echelon infantry would again be tired, out of the range of artillery support and communications, and essentially restricted to foot mobility. Thus, another passage of lines would be required. In theory, this was the stage when horse cavalry could use its greater mobility to exploit, although in practice a few machine guns could delay such exploitation significantly.

Thus, the timing of the decision to exploit and the problems of mobility across No Man's Land remained major obstacles for any attacker. Various solutions were tried. Some artillery batteries secretly moved forward prior to the battle and camouflaged themselves just behind the friendly first-line

trenches, allowing sustained artillery support to a slightly deeper range. Attacking brigades or regiments developed a system of leapfrogging, with second-echelon battalions passing through the attacking battalions to sustain the advance. Ultimately, however, the point would be reached where the attacker's advantages of artillery preparation and, if possible, surprise were cancelled out by the defender's advantages of depth, terrain, and operational mobility.

Of course, these problems could be minimized if the attacker did not try to achieve a complete penetration in any one attack, but settled for capturing a limited objective. Meticulous planning and preparation would allow such a surprise attack to succeed within the limits of artillery range and command and control capabilities, after which a new defense would be organized to halt the inevitable counterattack. French commanders such as Philippe Pétain were particularly noted for using this technique during 1917-18, after the French morale had been shattered by too many blind frontal attacks. Such a set-piece battle certainly improved morale and could achieve a limited victory at low cost; it could not, however, break the stalemate and win the war. Ultimately, a combination of attrition, new weapons, and new infantry tactics were required to achieve the elusive victory.

Flexible Defense

While the British, French, and later the Americans sought to solve the mystery of the penetration, the Germans gradually perfected their defenses against such a penetration. This evolution of German defensive doctrine was by no means rapid or easy, but the result was a system of flexible defense-in-depth that not only hindered attack but developed the capabilities of the German infantry.

At the beginning of the war, senior commanders on both sides emphasized a rigid defense of forward trenches. As the cost of taking ground increased, it seemed treasonous to surrender voluntarily even one foot of precious soil to an enemy attack. Moreover, many commanders believed that creating defenses-in-depth and allowing units to withdraw under pressure would encourage cowardice, as troops expecting a retreat would defend their positions only half-heartedly.¹⁰ Only gradually did German leaders realize that massing their forces in the forward trenches was suicidal; the artillery bombardment before a French or British attack eliminated many of the defenders in those trenches, increasing the possibility of enemy penetration. This was most obvious at the battle of Neuve Chapelle, when the single line of German trenches disappeared under the weight of a British bombardment, leaving nothing but a string of concrete pillboxes behind the lines to block the British advance until reinforcements arrived.

Beginning with the shock of Neuve Chapelle, Germany gradually evolved a system that by 1917 included up to five successive defensive lines, one behind the other, in critical sectors. The first two or three lines were sited on reverse slopes wherever the terrain permitted. This not only complicated the task of adjusting enemy fire on those trenches, but meant that the attacking British and French infantry were out of sight and therefore out of communication with their own forces when they reached the German defenses. At the same time, if a German trench on a reverse slope were captured, it would be fully exposed to fire and counterattack from the German rear positions. The rearward trenches were beyond the range of enemy light and medium artillery, making them more difficult to reduce.

Quite apart from the choice of terrain, the German defensive system emphasized three principles: flexibility, decentralized control, and counterattack. In terms of flexibility, the forward German trenches most exposed to bombardment contained few troops, with perhaps one battalion out of every four in the first two trenches. By contrast, the French put two-thirds of every regiment in these forward lines, with orders to hold at all costs. By 1916, the Germans had gone even further and had decided that trench lines were useful shelters only during quiet periods. Once a bombardment began, the rearward German troops moved into deep bunkers, while the forward outposts moved out of the trenches, taking cover in nearby shellholes. The British and French artillery bombarded the deserted trenches until their barrage passed and their infantry began to advance. At that point the Germans would come out of the shelters and open fire from the shellholes or from the remains of the trenches.

The second aspect of the German system was decentralized control. Squad and platoon leaders had considerable independence and might defend or delay anywhere forward of the third, or main, defense line. The forward or "Front Battalion Commander" frequently directed the entire defense of a regimental sector. In the mature system of 1917-18, this battalion commander had the authority to commit the remaining two or three battalions of his regiment in a counterattack at the moment he judged most appropriate. This only exaggerated the difference in decision cycles: while the British and French attackers had to seek orders and reinforcements from their corps or army commander located miles to the rear, the defending German battalion commander could direct a regimental counterattack on the spot.¹¹

This, in fact, pertains to the third element of the German defensive tactics: counterattacks at every echelon to retake lost ground before the attacker could consolidate. In those areas that seemed most vulnerable to attack, a second-echelon division was located behind every one or two front divisions,

ready to counterattack if needed. Whenever a major offensive began, the German defenders sought to contain the flanks of the penetration by blocking positions; counterattacks would then eliminate the resulting salient.

Such tactics did not evolve overnight. Many German commanders bitterly opposed the flexibility and decentralized control of the elastic defense. For example, at Passchendaele in July-August 1917, the local commander ordered all outposts to hold in place while awaiting the counterattack. The result was disaster, with many outposts being cut off. There is some evidence that the British incorrectly decided that this costly experiment was the real key to German defenses, leading to the rigid forward British defense that collapsed in March 1918.¹²

The combination of flexibility, decentralized control, and counterattack at every echelon made the German defensive system almost invincible until attrition and demoralization gave the Allies an overwhelming numerical superiority.

The Allies, by contrast, received fewer attacks from the Germans and therefore took longer to arrive at the same conclusions. A French directive of 8 July 1915 did require commanders to hold the majority of their troops in the rear for counterattack, but this order was frequently ignored. Not until the five German offensives of 1918 did French field commanders learn to array their forces in depth and accept the loss of lightly defended forward positions.¹³

Technological Change

Like all major wars, World War I accelerated the development of new technology. In addition to changes in artillery and communications, a number of new weapons appeared as the result of efforts to solve the penetration problem. None of these efforts was entirely successful, but they all represented additional weapons or tools to be combined with the traditional arms.

Gas warfare was the first attempt to break the trench defense. Although the French had experimented with various noxious gases on a small scale at the end of 1914, it was the Germans who first conducted major gas attacks. The first German test of gas took place in January 1915, at Łódź on the Russian front. Much of the chemical, however, failed to vaporize because of low temperatures. The first use on the Western Front was on 22 April 1915 at the Ypres salient. There a surprise attack routed French colonial troops on a five-mile front, but the Germans were not prepared to exploit their success. They had no significant reserves available to advance before the French sealed the breach. Thereafter, each side found that primitive

gas masks and uncertain weather conditions made the existing nonpersistent and early persistent agents difficult to employ successfully. When the British first used gas at Loos on 25 September 1915, the wind conditions were extremely calm, so that the gas moved too slowly or in the wrong direction along most of the front. The British troops advanced into their own gas, suffering more casualties than their opponents. The Germans, for their part, had problems with chemical warfare on the Western Front because the prevailing winds came from the west, often blowing gases back in their faces. Gas warfare became only an adjunct, useful to degrade enemy effectiveness but not to achieve a penetration by itself. By 1917-18, the most common use of gas was to mix chemical and high explosive artillery shells during a preparatory fire, in hopes of forcing the enemy out of his deep shelters where the gas settled.¹⁴

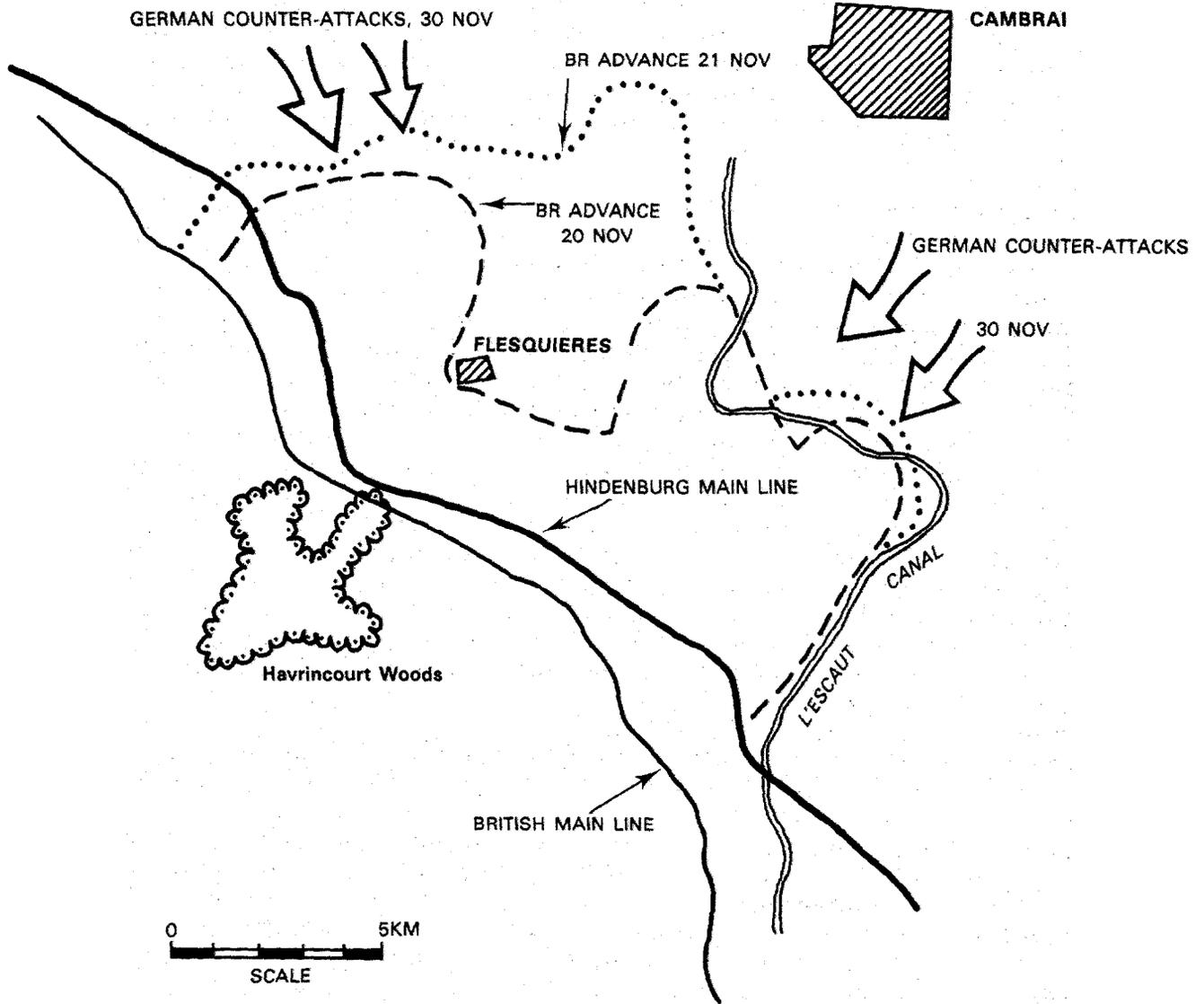
World War I was also the first conflict to have significant air action. Military aviation developed at a tremendous rate during the war, but was still in its infancy in 1918. All of the publicity went to fighter pilots, whose primary mission was to achieve local air superiority. This condition allowed the primitive aircraft of the time to conduct their more basic functions of reconnaissance and artillery fire adjustment. Not until 1917 did the British and Germans officially recognize the possibility of ground attack by fighters in the forward area, and both sides considered the main effect of such an attack to be demoralization rather than destruction.¹⁵ By 1918, the first bombers with significant payloads appeared, but in most cases reconnaissance and not bombardment was the critical contribution of air power.

The military motor vehicle also developed from a few primitive cars in 1914 to thousands of large trucks by 1916. Although not a tactical weapon, the truck allowed the rapid movement of troops and supplies between widely separated points. As such, it increased operational mobility as significantly as had the railroad in previous generations. This made it possible to mass suddenly and conduct a surprise attack at an unexpected point, or to move reserves to blunt a penetration. Trucks were also essential for stockpiling the ammunition and materiel needed for major offensives.

The tank was originally designed as a special weapon to solve an unusual tactical situation, the stalemate of the trenches. Basically, the tank was intended to bring the firepower of artillery and machine guns across the morass of No Man's Land while providing more protection than a purely infantry unit could carry. The sole purpose of this weapon was to assist the infantry in creating a penetration so that the cavalry, which had been waiting for the opportunity since 1914, could exploit into the German rear.

This purpose must be remembered in order to understand the shortcomings of early tanks. British and especially French heavy tanks had slow speeds, poor mechanical reliability, and great vulnerability to direct-fire artillery once the initial surprise wore off. After all, these new weapons had to advance only a few miles and then turn the battle over to the cavalry. Moreover, the great secrecy surrounding tank development, coupled with the skepticism of infantry commanders, often meant that infantry had little training to cooperate with tanks. As a result, the infantry would become separated from the tanks, allowing the German infantry to defeat the two arms separately. Generally speaking, infantry that had the opportunity to train with tanks before battle and to work with tanks in battle swore by them, while infantry that was thrown into battle without prior tank training swore at them.

Small, local attacks, beginning at Flers on the Somme on 15 September 1916, dissipated the initial surprise of the tank. Not until 20 November 1917, at Cambrai, did the British Tank Corps get the conditions it needed for success. Using new survey techniques, the British guns moved into position without firing ranging shots prior to the attack. The tanks then began to move forward at the start of a very short artillery bombardment, with the infantry following in the lee of the tanks. The elimination of a long artillery preparation not only achieved surprise, but also left the ground more trafficable. Four hundred seventy-four heavy tanks in three brigades had practiced extensively with five of the six infantry divisions they accompanied. Tanks operated in sections of three: one tank used machine gun fire and its treads to suppress the defending infantry, while the other two tanks, accompanied by British infantry, crossed the trenches. These tactics worked well except at Flésquières Ridge, in the center of the Cambrai sector. Here the commander of the 51st Highland Division, believing that German fire would be focused on the armor, had forbidden his infantry to come within 100 yards of their tanks. Furthermore, the Royal Flying Corps erroneously reported that it had driven off the German artillery in the area, whereas one enemy battery had moved onto the reverse slope of the ridge. As a result, the British tanks were unsupported when they slowly topped the ridge. Direct-fire German artillery knocked out sixteen unmaneuverable tanks in a few minutes.¹⁶ This incident convinced many people that armor could not survive when separated from infantry, an attitude that persisted after 1918, even when tank speed and maneuverability improved. In any event, the available tanks were distributed evenly across the Cambrai front, leaving no reserve to exploit the greatest success. Moreover, because of the attrition battles of 1916-17, the British had few infantry reserves to commit at Cambrai--they had regarded it as a raid rather than another attempt to penetrate.



Map 1. Battle of Cambrai, 20-30 November 1917.

The usual problems of Allied generals commanding from the rear meant that the Germans rebuilt their defenses before the British cavalry moved forward to exploit. Ten days after the British offensive at Cambrai, the Germans counterattacked and restored the original front. In its own way, this counterattack also reflected the latest developments of the war: surprise, colored flares to shift artillery at phase lines, and multiple attacking waves to clear out British strongpoints bypassed by the first wave.

Even before Cambrai, the Germans had begun to develop an antitank doctrine. In marked contrast to the beliefs of British armor commanders, the German commanders were more concerned by the psychological effect of tank attacks than by the limited firepower and armor of the tanks themselves. Psychological effect rather than infantry support was the point emphasized by postwar German theorists. In 1917-18, however, the Germans lacked the resources to compete in tank production. Instead, they relied upon obstacle plans combined with existing light artillery pieces (the 77-mm guns) and some armor-piercing rounds for infantry weapons. These rounds were effective against early British tanks, and by 1918 the Germans had developed oversized antitank rifles against later British models. To combat the terror of tanks, German troops received training on how to defeat them. Where possible, German infantry would wait until the attacking tank had passed, engage the accompanying British infantry, and throw bundles of grenades to disable a tank tread.¹⁷

By 1918, tanks were extremely vulnerable unless accompanied by infantry and ground-attack aircraft, both of which worked to locate and suppress antitank defenses. During the first three days of the battle of Bapaume in August 1918, German antitank defenses or mechanical failures immobilized 81 percent of the attacking tanks.¹⁸ Any tank that broke down on the battlefield was almost certain to be knocked out by antitank fire in a few minutes. Again, such experiences shaped perceptions of tank capabilities and roles long after technological change had restored the tank's initial advantage.

The French, British, and (with French equipment) Americans organized light tank units in 1918. The British "Whippet" tank was faster (7.5 miles per hour versus four miles per hour) than most heavy tanks, but was still hardly a vehicle for rapid exploitation. Light tanks were much easier to redeploy in secret from one sector to another, because they could be loaded onto trucks instead of moved by rail.

Although the Royal Tank Corps experimented with special armored vehicles in which to transport radios, supplies, and even

machine guns, all tank units in World War I were just that--pure tank formations of up to brigade size, intended for attachment to infantry units rather than for independent combined arms mechanized operations of their own.

Gas warfare, aviation, motor transport, and tanks had two effects, other than those derived from their individual tactical characteristics, on the positional battlefield of World War I. On the one hand, their development made the problem of combining different weapons for attack or defense much more complicated. This reinforced the tendency for detailed planning and centralized control at a time when infantry-artillery cooperation was still being developed. On the other hand, the army that succeeded in this orchestration had a much better chance of eventually defeating its opponent by attrition, even if penetration was never achieved.

The Resurgence of Infantry

Most of the developments in artillery, gas warfare, aircraft, and armor were based on the supposed inability of 1914 infantry to advance under fire. During the course of World War I, however, the infantry gradually evolved to a point where it had recovered some of its original ability to take and hold terrain on its own. In the process, modern infantry organization was developed.

The 1914 infantry battalion was almost exclusively armed with rifles, plus a few heavy and almost immobile machine guns. As soon as the effects of firepower became evident on the battlefield, however, the infantry of various armies sought to increase their own firepower in return. The first such effort was the trench mortar. Mortars had existed as a form of heavy artillery for centuries, but in 1914 the German Army introduced a limited number of small, cheap, portable minenwerfers, which were breech-loading, low-trajectory mortars. Other armies quickly copied the minenwerfer, and in March 1915, the English engineer Wilfred Stokes developed the grandfather of all current infantry mortars, the 3-inch muzzle-loading Stokes mortar.¹⁹ This weapon was much simpler to manufacture than artillery and therefore was employed extensively in all armies during the war. However, larger caliber mortars were often classified as weapons for artillerymen or, in the German Army, for engineers, and thus placed in batteries and battalions separated from the infantry.

As early as 1915 the French began to issue other new weapons to the infantry, notably the light automatic rifle and the rifle grenade launcher. These, plus ordinary hand grenades, gave the

French infantry more mobile automatic firepower and short-range (up to 150 meters) indirect-fire capability. On 27 September 1916, France reorganized the infantry company to consist of a headquarters, which included communications and pioneer (combat engineer) personnel, plus four platoons of two sections each. Within these twelve-men sections, hand grenadiers, rifle grenadiers, and riflemen were organized around the automatic rifleman as the base of fire. Three of these infantry companies, plus a company of eight heavy machine guns and a 37-mm gun in the headquarters, made up an infantry battalion that modern infantrymen can recognize as such. Other armies adopted similar armament and organizations, although the Germans delayed until 1917. The German preoccupation with accuracy of fire by heavy machine guns made them reluctant to accept the relatively inaccurate light machine guns and automatic rifles, until in desperation the frontline German infantry began to use captured French automatic rifles.²⁰

The resulting changes in infantry tactics were slow to take root. In May 1915, an obscure French captain named André Laffargue privately published a pamphlet that suggested a variety of innovations, including not only trench mortars but so-called skirmisher or sharpshooter groups. These groups, armed with light machine guns, rifle grenades, and hand grenades, would precede the main assault wave by fifty meters. Their mission was to provide covering fire for the main attack and, if possible, to infiltrate through the forward German positions to suppress and outflank German machine gun posts. The French government distributed but did not endorse this pamphlet; the British largely ignored it and were among the last to give up the linear advance. Not until 1916 did the French officially reduce the density of their skirmish lines to one man every two, and later every five, paces, as opposed to every pace, and integrate the new weapons fully into infantry organization. Meanwhile, the Germans captured a copy of Laffargue's pamphlet during the summer of 1916 and may have adapted parts of it to their own tactical doctrine.²¹

The evolution of German offensive tactics during World War I was slower than that of the elastic defense. Although the Germans as early as Verdun in 1916 used small groups of riflemen, machine gunners, and engineers to infiltrate past the French outposts at the start of an attack, their new infiltration tactics actually evolved in 1917 on the Russian and Italian fronts, in the battles of Riga and Caporetto. These tactics are sometimes called, probably erroneously, "Hutier tactics." Gen. Oskar von Hutier commanded such attacks on the Russian and Italian fronts during 1917 before directing one of the field

armies in the German spring offensive of 1918, but he did not invent the concepts. Some German officers have since denied the very existence of the "infiltration" or "soft-spot" tactics, and in fact the victories of 1918 were probably the result of the intelligent application of lessons learned against the Russians and Italians, rather than any sudden innovation in tactics. It is clear, however, that the German Chief of Staff, Erich von Ludendorff, issued a set of offensive instructions dated 8 February 1918, which directed infantry to attack on its own using machine guns, rifles, grenades, light mortars, and accompanying direct-fire artillery pieces. During early 1918 as many as seventy divisions rotated through a special training course in the new offensive tactics.²²

The result was the astonishing German success of March and April 1918. The tactics involved represented the culmination of German developments in combined arms during World War I. The spirit behind these tactics, when combined with armored equipment, had much to do with the later German blitzkrieg.

The Return Of Mobility, 1918

The German infiltration tactics of 1918 can be summarized under four headings: Bruckmüller artillery preparation; the combined arms assault or storm battalion; rejection of the linear advance in favor of bypassing enemy centers of resistance; and attacks to disorganize the enemy rear area.

Col. Georg Bruckmüller, an obscure officer retired for nervous problems in 1913 but recalled to duty for the war, developed German artillery techniques to a fine art. The essence of the Bruckmüller artillery preparation was a carefully orchestrated, short but intense bombardment designed to isolate, demoralize, and disorganize enemy defenders. Before each of the great offensives, Bruckmüller and his assistants held classes for junior leaders of both artillery and infantry, explaining what would take place. The result was not only unprecedented understanding and cooperation, but a much greater confidence on the part of the infantry. Next, Bruckmüller allocated different weapons against different specific targets. For example, each trench mortar was given only twenty-five to thirty meters of enemy front to engage, while each artillery battery was assigned to suppress a specific enemy battery or to attack 100 to 150 meters of enemy positions.²³ Bruckmüller avoided area targets, concentrating on such key points as artillery observation posts, command posts, radio and telephone centers, rearward troop concentrations, bridges, and major approach routes. He carefully pinpointed all these targets on aerial photographs. The result was to cut enemy communications and isolate forward units. The effect was increased by surprise. Using the survey techniques

developed in all armies during 1916-17, Bruckmüller was able to position and range his batteries in secret from points immediately behind the forward infantry trenches.

At the start of the German offensive on 21 March 1918, Bruckmüller began his bombardment with ten minutes of gas shells to force the British to mask, followed by four hours and twenty-five minutes of mixed gas and high explosives.²⁴ The preparatory fires shifted back and forth, so that the British did not know when the artillery was actually lifting for the infantry advance. Meanwhile, automatic rifle teams moved as close as possible to the British positions during the bombardment.²⁵ When the Germans did advance, they moved behind a rolling barrage, further enhanced by intense fog. The combination of surprise, brevity, intensity, and carefully selected targets was unique.

The combined arms assault or storm battalion was a union of all the weapons available after years of trench warfare, weapons which could be focused by a battalion commander. A typical assault battalion task force consisted of:

- 3-4 infantry companies
- 1 trench mortar company
- 1 accompanying artillery battery or half-battery of 77-mm guns
- 1 flamethrower section
- 1 signal detachment
- 1 pioneer (combat engineer) section

The regimental commander might attach additional machine gun units and bicyclists. The accompanying artillery pieces did not participate in the artillery preparation, but waited behind the infantry, ready to move immediately. One of the principal tasks of the pioneers was to assist in the movement of the guns across obstacles and shellholes. Upon encountering a center of resistance, the infantry provided suppressive fire, while the guns, mortars, and flamethrowers attempted to eliminate that resistance. Despite a specially constructed low carriage on some 77-mm guns, the result was a very high casualty rate among the exposed crews, although the disorganized state of British defenses made such situations relatively rare.²⁶

The essence of the German tactics was for the first echelon of assault units to bypass centers of resistance, seeking to penetrate into the enemy positions in columns or squad groups, down defiles or between outposts. Some skirmishers had to precede these dispersed columns, but skirmish lines and linear tactics were avoided. The local commander had authority to continue the advance through gaps in the enemy defenses without

regard for events on his flanks. A second echelon, again equipped with light artillery and pioneers, was responsible for eliminating bypassed enemy positions. This system of decentralized "soft-spot" advances was second nature to the Germans because of their flexible defensive experience. At the battle of Caporetto in 1917, the young Erwin Rommel used such tactics to bypass forward defenses and capture an Italian infantry regiment with only a few German companies.²⁷

The final aspect of the German infiltration tactics was the effort to disorganize the enemy rear. The artillery preparation began by destroying communications and command centers; the infiltrating infantry also attacked such centers, as well as artillery positions. The British defenders who opposed the first German offensive of 1918 lost all organization and retreated thirty-eight kilometers in four days. Col. J.F.C. Fuller, one of the foremost British tank tacticians, observed that the British seemed to collapse and retreat from the rear forward. Major British headquarters learned of multiple German attacks on forward units just before losing contact with some of those units. The higher British commanders then ordered their remaining forces, which were often successfully defending their bypassed positions, to withdraw in order to restore a conventional linear front.²⁸

The German spring offensives ultimately failed for a variety of reasons, including lack of mobility to exploit initial successes and lack of clear strategic objectives. As a result, Ludendorff dissipated his forces in a series of attacks that achieved tactical success but no operational or strategic decision.

In other words, the German offensive of 1918 used tactics and organization that could be described as a blitzkrieg without tanks, disorganizing and demoralizing rather than systematically destroying the defender. This was especially easy to do against a World War I army, where the static nature of deployments and telephone communications had combined with the elaborate planning necessary for a set-piece battle to produce a defender who had great difficulty reacting to sudden changes. Both sides found that their soldiers no longer knew how to fight in open terrain, but dug in immediately whenever they broke through the enemy defensive system.

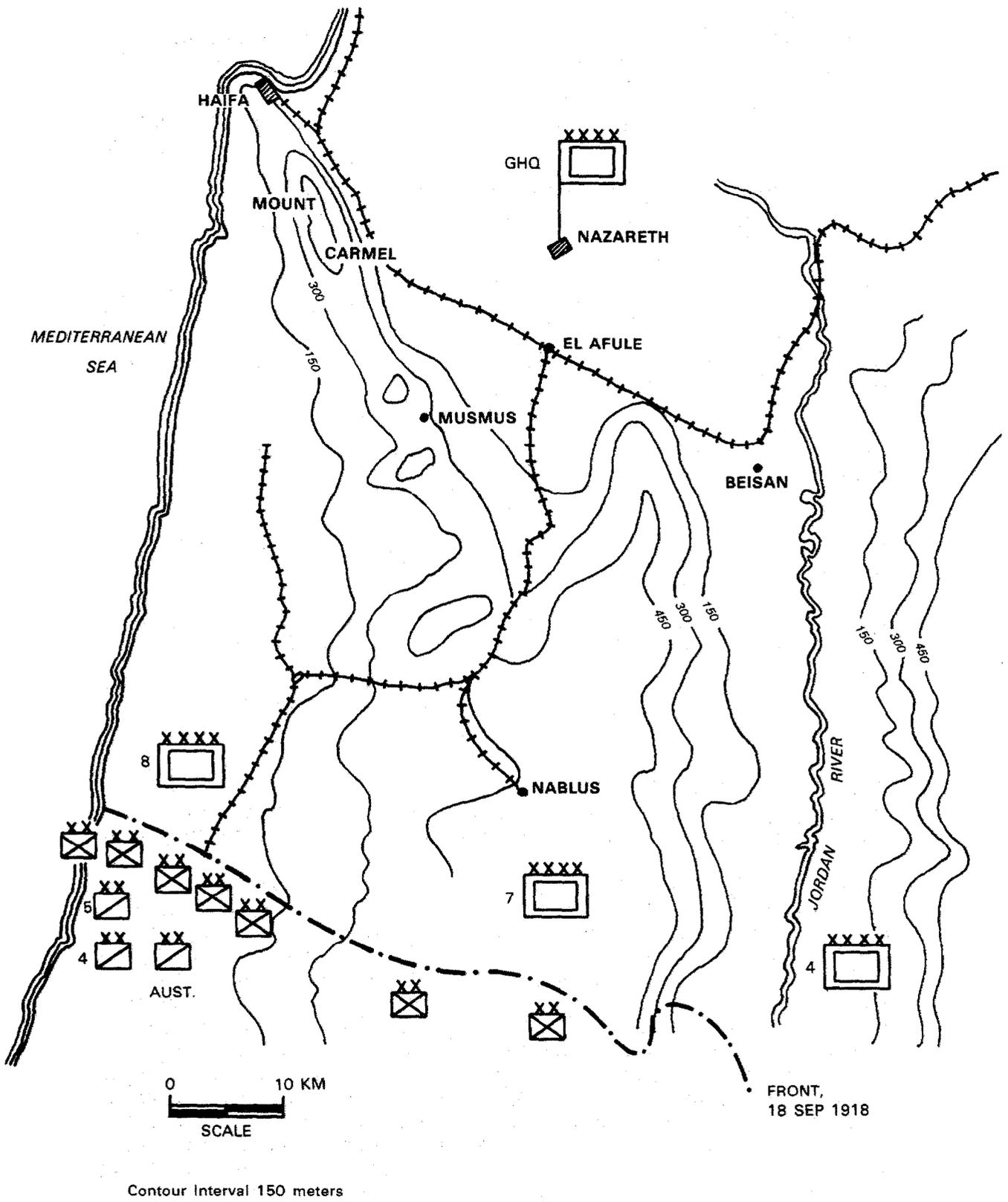
The German spring offensives of 1918 were the most obvious example of mobility returning to the battlefield, but in fact all armies in 1918 were better able to attack than they had been in the preceding three years. Beginning on 15 July 1918, the British, French, and Americans launched a sustained series of attacks that combined all the Allied innovations made during the war. Infantry units used renewed mobility and firepower, plus

tanks to precede them and suppress enemy strongpoints. Airpower provided limited ground-attack capability plus reconnaissance both before and during the battle. This air reconnaissance focused on antitank threats to the advancing forces. Artillery had become much more sophisticated and effective than in 1914. Most important of all, the different weapons and arms had learned to cooperate closely, at least in carefully planned set-piece operations. Commanders could no longer rely on one or even two arms, but had to coordinate every available means to overcome the stalemate of the trenches.

Despite all this, the 1918 offensives in France never achieved a decisive result on the battlefield, and the Germans were defeated more by sustained attrition and demoralization than by any decisive penetration and exploitation.²⁹ One of the few cases in which a 1918 army penetrated a prepared defense and then exploited with conclusive results occurred in Palestine rather than France, where the British defeated Germany's ally, Turkey. This victory is known as the second battle of Armageddon or Megiddo (Map 2), because it was fought in the same area as the original battle of 1479 B.C.³⁰

The British commander, Sir Edmund Allenby, had steadily advanced from Egypt through Palestine against a Turkish army with a German commander, Liman von Sanders, and a few German units. The Turkish government had diverted its resources elsewhere, so that in 1918 the British outnumbered the Turks two to one. Allenby further increased his advantage by a detailed deception plan that convinced the Turks that the British would attack at the eastern end of the front, in the Jordan Valley. The actual attack was then conducted in the west, near the seacoast. The fact that the British possessed a tremendous numerical advantage does not detract from the significance of the second battle of Armageddon in terms of its tactical methods and strategic objectives.

Allenby used all available elements, beginning with irregular troops in the enemy rear areas. On 17 September 1918, two days before the planned offensive, the famous T. E. Lawrence and Prince Feisal of Arabia conducted a wave of attacks on Turkish rail lines in order to divert attention and isolate the battlefield. The Royal Air Force also harassed Turkish lines of communications for days. At 0430 on 19 September, the British infantry began to move forward behind a fifteen-minute artillery barrage. This short preparation achieved surprise and avoided tearing up the ground. Moreover, the long delays in assembling troops and supplies prior to the offensive had enabled the British and Commonwealth infantry to train to high standards of flexibility. Unlike the campaigns in France, exploitation forces



Map 2. Second Battle of Armageddon, 19-24 September 1918

did not have to wait for authority to engage. Instead, one Australian and two British cavalry divisions began the battle closed up tightly behind the assaulting infantry, with exploitation objectives already designated. Because of this decentralized control, the 4th Cavalry Division had completed its passage of lines and had begun the exploitation within four hours of the initial assault.

The primary objectives of the campaign were the railroad junctions at El Afule and Beisan, forty miles behind the front; a secondary objective was Nazareth, the German-Turkish headquarters. Seizure of these points would cut off the forward Turkish units from their supplies, commanders, and route of retreat. The key was to move cavalry through the passes of the Mount Carmel heights so rapidly that the Turks could not react to block the passes. This was accomplished on the evening of the first day. The next morning, a brigade of the 4th Cavalry Division encountered a reinforced Turkish infantry battalion marching forward in a belated effort to block the pass at Musmus. A combination of armored car machine gun fire and horse cavalry lances captured this battalion before it ever deployed. Twenty-five hours after the offensive began, another British cavalry brigade surrounded Nazareth, which had been isolated and harassed by air attacks. Although the German commander escaped in the confusion, the British captured all the documents in the enemy headquarters. The Turkish Seventh and Eighth Armies, except for a few hundred stragglers, surrendered in mass, and only the November armistice ended the British pursuit.

The significance of Second Armageddon was threefold. First, it represented a rare ability to make a transition from penetration to exploitation and pursuit before the defender could react. The key to this success, apart from numerical superiority, was the fact that the exploitation force did not wait for permission from higher headquarters, but was committed on the decision of division commanders and in execution of a previously arranged plan. Second, Allenby used all his weapons and units in a flexible and integrated manner that was matched in World War I only by the Germans. Finally, Second Armageddon influenced an entire generation of British cavalry officers, who considered it the model of a mobile, deep battle. After the frustrations of trench stalemate in France, the exploitation in Palestine seemed a dream come true. When these cavalry officers became armor commanders, they stressed the need for mobile, lightly armored vehicles. As a result, one-half of the British armored force in 1939 was equipped with inadequate guns and armor and was not prepared to cooperate with the other combat arms.

Organizational Results

In addition to the changes in infantry battalion structure, the rapid development of weapons and tactics during World War I significantly changed tactical organizations. The number of automatic weapons in an infantry division rose from a norm of twenty-four heavy machine guns in 1914 to the following totals in 1918:

Germany: 144 automatic rifles and 54-108 machine guns
France: 216 automatic rifles and 72-108 machine guns
Britain: 192 automatic rifles and 64 machine guns
Italy: 288 automatic rifles and 72 machine guns
United States: 768 automatic rifles and 260 machine guns³¹

Artillery developed almost as dramatically, although most of the additional guns were concentrated in nondivisional units whose numbers varied depending on the mission of the division being supported. As Gen. Wilhelm von Balck, a major German tactician both before and after the war, remarked:

The question as to the proportion of the artillery is no longer: 'How many guns for each thousand men should be provided?', but far rather: 'How much infantry will be required to utilize the success of the fire of the artillery?' . . .there are no longer principal arms. Each arms has its use, all are necessary.³²

More complex problems drove other organizational changes. For example, both the French and the Germans found that the square division structure, with two brigades each of two regiments, was unsuited to positional warfare. Given the broad frontages involved in this type of war, no European power had enough manpower and units to deploy divisions with two regiments in first line and two in second. If, on the other hand, three regiments were in the first line and the fourth regiment served as a general reserve, one of the two infantry brigade commanders was superfluous. So the Germans left one brigade commander in control of all infantry, and by 1916 both the French and the Germans had reduced the number of infantry regiments in a division from four to three (Figure 4). The British had entered the war with a three-brigade structure, which they retained, but they eventually followed suit by reducing the brigade from four infantry battalions to three when manpower shortages became acute. This had the added advantage of increasing the proportion of artillery and other branches to infantry, although the Germans moved part of their artillery into nondivisional units. Thus, a

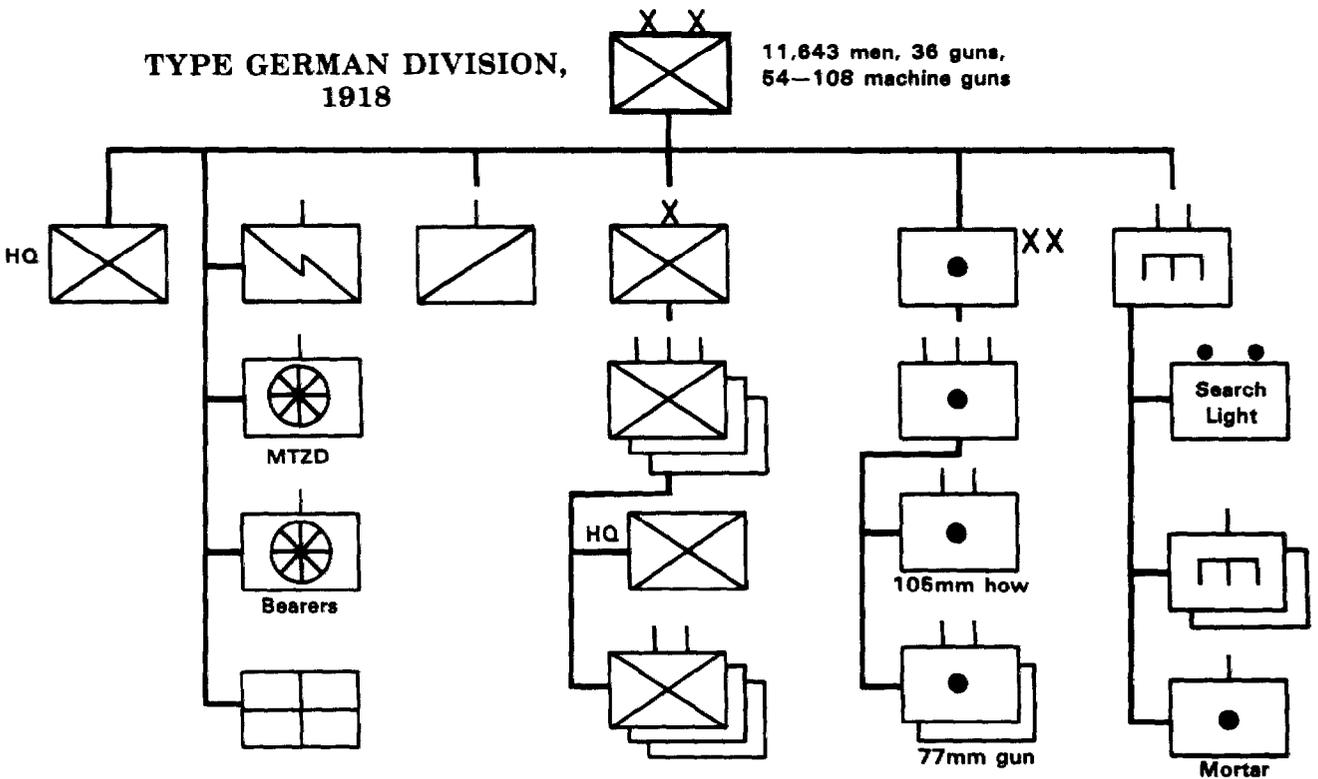
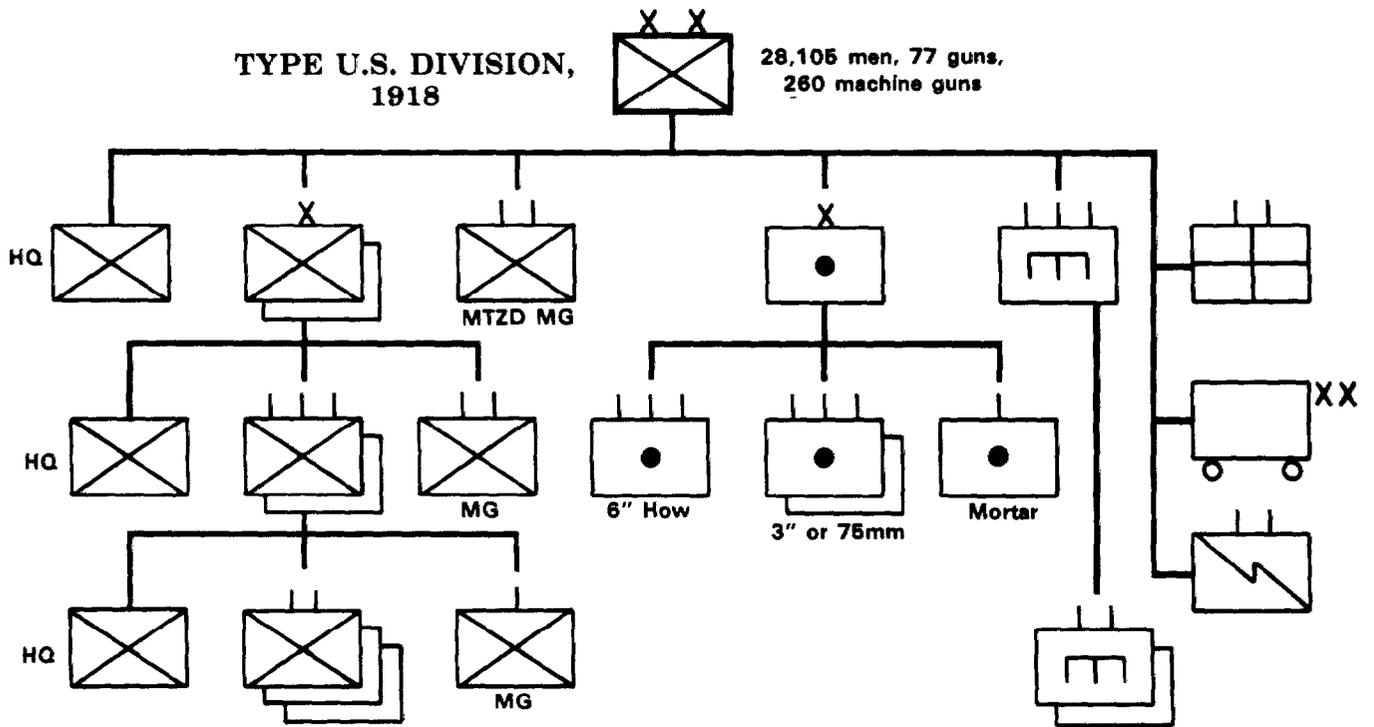


Figure 4. Type U.S. and German Divisions, 1918

1914 French infantry division consisted of 87 percent infantry, 10 percent artillery, and 3 percent support elements, while the 1918 version had a proportion of 65 percent infantry, 27 percent artillery, and 8 percent support.³³

The one exception to this trend was the United States Army, which not only insisted upon a four-regiment structure, but actually increased the size of rifle companies during 1917 (see figure 4). The result was a division that varied in size from 24,000 to over 28,000 men, a giant considering the average strength of a European division was down to 8,000 men or fewer. In fact, the French and British commanders who controlled American divisions refused to use them according to their design and, instead, pushed them into line with three regiments forward and the fourth either in second echelon or in corps reserve. In one instance, the 42d U.S. Infantry Division assumed the defense of a sector previously occupied by an entire French corps of three divisions.³⁴ In principle, however, the American design was intended to provide for sustained offensive and defensive operations despite the high casualties of trench warfare. The apparent intent was that an American brigade commander, with one regiment in contact and the second behind it, could leapfrog his regiments to sustain an offensive almost indefinitely, thereby cutting the decision cycle time necessary to relieve exhausted assault troops. Unlike all higher commanders on the Allied side, this colonel or brigadier general had only a few aides and was free to command from forward locations. The only reserve available to the division commander was the two-battalion combat engineer regiment, which was frequently pressed into service as infantry.

Even though the Americans differed with their allies about many details, all participants came away from World War I with certain impressions in common: the tremendous problems of logistics and manpower; the necessity for detailed planning and coordination; and the difficulty of advancing even when all arms worked closely together. Under carefully planned and controlled circumstances, the Allies had been able to combine all weapons systems to maximize the effects of each. Of all the belligerent systems for achieving this combination, the German proved to be most adaptable to new weapons and tactics.

CHAPTER THREE

THE INTERWAR PERIOD

The conventional image of military affairs and doctrine between the two world wars depicts most armies as rigidly committed to a repetition of the positional warfare of 1914-18. According to this view, only Hitler's Germany listened to the advocates of mechanized warfare, with the result that between 1939 and 1941 the German blitzkrieg achieved almost bloodless victories over the outdated Polish, French, and British armies.

The reality was much more varied and complex. No major army entered World War II with the same doctrine and weapons that it had used twenty years before. During the interwar period, the majority of professional soldiers recognized that some change was necessary if they were to perform better the battlefield functions of penetration and exploitation that had proven so difficult during World War I. Yet armies differed markedly in their solutions to these problems. Instead of a simple choice between trench warfare and blitzkrieg, each army was faced with a variety of possible changes, a series of degrees of modernization between the two extremes. In many cases, the choice was determined by social, economic, and political factors more than by the tactical concepts of senior officers. Even in Germany, the advocates of mechanized warfare did not have a free hand. In a real sense, the German forces and doctrine of 1939 were not so much the perfect solution as they were simply a solution that was closer to the problems of the moment than were the organizations and doctrine of Germany's early opponents.

Because of this tactical variety between the world wars, the doctrine and organization of each of the major powers must be considered up to the point at which that nation entered World War II. Before reviewing these armies, however, it is necessary to examine some common factors that hampered military change in most nations.

The first of these factors was a general revulsion against warfare and all things military. After decades of peacetime preparation and years of incredible bloodshed, few people in Europe or America were interested in further military expenditures or experiments with new weapons and tactics. Particularly in France, firepower seemed so great that few soldiers foresaw any type of offensive success against prepared enemy positions without the combination of a mass army with tanks, artillery, and attrition tactics, the means that had succeeded in 1918. Even after most armies concluded that trench warfare was a special kind of combat that would not necessarily recur, the general public and political leadership were unwilling

to risk another war. In 1928, fifteen nations signed the Kellogg-Briand Pact, renouncing the use of war except in national self-defense. During the 1920s and early 1930s, a series of international conferences attempted to limit military and naval armaments. Although these conferences ultimately failed, it was difficult for professional soldiers to justify the purchase of new weapons such as tanks and aircraft in a social and political environment that might outlaw such weapons at any time.

During the first fifteen years of peace, extremely tight defense budgets reflected the public distaste for warfare. The victorious armies were saddled with huge stockpiles of 1918-model equipment and ammunition and had to use up these stockpiles at peacetime rates before major new expenditures could be justified. Thus, during the early 1930s the U.S. Army spent more money researching means to preserve ammunition than to develop new weapons.¹ Just as the stockpiles were consumed or worn out, the Great Depression caused even tighter defense budgets, which hampered development and procurement of tanks, aircraft, and other new weapons. The Germans, by contrast, had been deprived of their weapons by the Versailles Peace Treaty of 1919 and could therefore start fresh. To some extent, the German tactical successes of 1939-42 were due not to any superiority in equipment quality or quantity, but rather to the fact that the German tanks and other vehicles were produced early enough to allow extensive experimentation and training before the war. In contrast, the British and French had few modern weapons with which to train until the very eve of World War II, when they mass-produced them on a crash basis. Nations with a smaller industrial base, such as Japan and Italy, could not fully compete in the arms race. The Japanese selectively built a few types of warships and aircraft of high quality. In land warfare, they relied upon training and morale to make up for weapons that they could not afford to mass-produce. Italy lacked not only production facilities, but equipment design capability and even public understanding of automobiles and other machinery. As a result, the Italians failed to produce any modern, well-designed weapons.²

A third factor was technology, which affected military change in two ways. On the one hand, rapid changes in technology made governments even more reluctant to invest in existing designs that would soon be outmoded. In 1938, for example, the Inspector-General of the French Air Force had to advise the French and British governments to avoid a showdown at Munich because he believed that the majority of French combat aircraft were suddenly obsolescent; new developments such as flush-riveted metal construction gave the German Luftwaffe the appearance of technical superiority.³ On the other hand, it was often difficult to determine exactly how this new technology affected

the tactics of 1918. Equipment designed to fulfill these tactics might be unsuitable for different functions and concepts, while new designs appeared without appropriate tactical concepts to accompany them.

There was also considerable confusion in terminology. Both advocates and opponents of mechanization often used the term "tank" loosely to mean not only an armored, tracked, turreted, gun-carrying fighting vehicle, but also any form of armored vehicle or mechanized unit. Such usage made it difficult for contemporaries or historians to determine whether a particular speaker was discussing pure tank forces, mechanized combined arms forces, or mechanization of infantry forces. Similar confusion existed about the term "mechanization." Strictly speaking, any use of the gasoline engine for warfare could be termed mechanization. However, this term is usually employed to describe the use of armored tracked combat vehicles. By contrast, "motorization" describes the use of motor vehicles that are not intended to go into combat, but which may improve logistics and mobility off the battlefield. No nation in the world could afford to mechanize fully in this sense, but all armies made some motions in the direction of motorization. Indeed, there was almost no choice about the matter. Prior to World War I, all nations relied on a pool of civilian horses as transportation in case of war. With the rise of motor vehicles during the 1920s, this supply of civilian animals declined to the point where armies had to base their transportation planning on motor vehicles.⁴ Thus, motorization was often seen as an easier, cheaper, less revolutionary change than mechanization.

Fifth, advocates of change did not always speak persuasively or with one voice even when their terms were understood. Even those reformers with a clear vision of mechanized, combined arms war were often so extreme in their statements that they alienated the men they needed to convert, the commanders and politicians who set military policy. In the French and Soviet cases, political issues retarded the development of new mechanized formations. Moreover, proponents of strategic airpower such as William Mitchell and Emilio Douhet made exaggerated claims that retarded the development of the tactical combined arms team. Intent on achieving independence from army control, the airpower advocates vigorously opposed tactical air support and air-ground cooperation; they considered the targets involved to be too minor to justify risking aircraft. These air enthusiasts had a limited success as publicists, influencing politicians with an apparently cheap, efficient solution to defense needs. As a result, funds were diverted from valuable training or ground weapons development to build air forces that were not in proportion to their respective armies. This leads to the sixth and final common factor, the opposition of the more traditional combat

arms. Many commentators have blamed such opposition for thwarting or retarding the development of mechanized warfare. There is some truth to this accusation, as will be seen below. Yet the tank and the aircraft were not the only weapons systems that developed between the world wars. The older branches had genuine needs that competed with new weapons for funding and for roles in the combined arms team. The infantry had legitimate requirements for increased organic firepower, for antitank and antiaircraft defenses, as well as for some form of armored support to assist it in the deliberate attack. The artillery needed the same mobility as the armored forces in order to support those forces in the breakthrough. Fast moving mechanized formations required more flexible communications and fire support. Combat engineers, which had become preoccupied with maintaining lines of communication during the positional warfare of 1914-18, were more important than ever when mechanized units increased the problems of mobility and countermobility on the battlefield. As a result, although much of this chapter will focus on the development of mechanized formations and tactics, such development must be viewed within the context of a more traditional mass army. Any nation that created a mechanized elite ran the risk of dividing its army, with catastrophic problems of coordination and morale.

Great Britain: "Hasten Slowly"⁵

In 1918, Great Britain led the world in both armored equipment and armored doctrine. At a time when most soldiers regarded the tank as a specialized infantry-support weapon for crossing trenches, a significant number of officers in the Royal Tank Corps had gone on to envision much broader roles for mechanized organizations. In May 1918, Col. J.F.C. Fuller had used the example of German infiltration tactics to refine what he called "Plan 1919." This was an elaborate concept for a large-scale armored offensive in 1919, an offensive that would not only produce multiple penetrations of the German forward defenses, but also totally disrupt the German command structure and rear organization. Fuller's expressed goal was to defeat the enemy by a "pistol shot to the brain" of enemy headquarters and communications, instead of by destroying the combat elements through systematic attrition. In order to attack German headquarters before they could displace, Fuller relied upon the Medium D tank. Potentially, the Medium D could drive at twenty miles per hour, a speed that would allow it to exploit the rupture of trenches caused by slower heavy tanks. In fact, the Medium D suffered the usual developmental problems of any radically new piece of equipment and might not have been available even if the war had continued into 1919. Moreover, then as later, Fuller was noteworthy for his neglect of infantry in the mechanized team. He could and did conceive of trucked

infantry advancing after the tanks under certain circumstances, but not fighting in close coordination with armor except at the point of rupture in a deliberate attack.⁶

Despite the efforts of numerous innovators like Fuller, the British Army gradually lost its lead not only in armor but in most areas of tactical progress. In addition to the six common factors previously discussed, there were several special obstacles to continued British innovation.

The most commonly cited obstacle was traditionalism within the British Army. This institutional resistance has often been exaggerated, but certainly the strong unit identity of the British regimental system discouraged radical changes within the traditional arms and services. A related problem was that Great Britain was the first nation to create an independent air force. The Royal Air Force (RAF) was intent upon developing its own identity as a separate service and resisted any close relationship with the army. Like most other air services, the RAF was increasingly interested in interdiction and strategic bombing, but not ground support. In 1922, for example, the army requested that eight "Army Co-Operation Squadrons" be permanently assigned for liaison and reconnaissance duties with ground troops. The RAF would only provide three squadrons. During mechanized exercises in 1928, a number of RAF pilots practiced close air support for armored units, but after this display the Air Ministry formally requested that the army refrain from encouraging pilots to violate RAF doctrine.⁷ This limitation was clearly reflected in British Army regulations from 1924 onward, where the RAF was described as providing only liaison and reconnaissance in the immediate proximity of ground units. Fighter aircraft could conduct strafing and other ground attacks "in exceptional circumstances," but only at the expense of their air superiority mission. Despite the efforts of many British armored theorists, close air support doctrine was not really developed in Britain until 1942.⁸

The problem of imperial defense also limited change. Since 1868, most British troop units stationed at home exchanged places with units overseas on a regular basis. In particular, a large portion of the British Army was always stationed in the Middle East and India. These overseas garrisons required large numbers of infantrymen to control civil disorders and made logistical support of elaborate equipment and weapons difficult. Consequently, a unit in the British Isles could not be motorized or mechanized without considering the effect of this change on that unit's performance in low intensity, imperial police operations. This did more than delay mechanization. It also meant that in designing armored fighting vehicles the British

were often thinking about the requirements of warfare against relatively unsophisticated opponents, and not against well-armed European forces.⁹

Despite these limitations on innovation, British doctrine did not stand still during the 1920s. A repetition of World War I seemed unthinkable, so positional warfare rapidly declined in British doctrine to the status of a special case. Instead, the British returned to the concepts of open, maneuver warfare that had been common before 1914, updating those concepts only to allow for the effects of firepower and motor vehicles. The 1924 Field Service Regulations considered infantry support to be the chief mission of tanks, but also recognized the possibility of tanks attacking the enemy flanks and rear to disorganize the opponent, as envisioned by Fuller. These regulations showed a serious and practical concern with the problems of antitank and anti-aircraft defense of all arms, although actual weapons for these problems were slow to appear. By 1929, British regulations had abandoned the old belief in the primacy of infantry, which instead became "the arm which confirms the victory and holds the ground won" by a close cooperation of all arms. Still, this cooperation was apparently to be achieved by detailed, meticulous planning of the 1918 variety. Coordination in encounter battles was much more difficult.¹⁰

At the same time the British, despite significant budgetary restrictions, were able to motorize parts of their artillery and supply units and to continue development of the small Royal Tank Corps. In 1927-28, an Experimental Mechanized Force conducted brigade-level exercises in Britain. This force included a light tank battalion for reconnaissance, a medium tank battalion for assault, a machine gun battalion for security and limited infantry operations, five motorized or mechanized artillery batteries, and a motorized engineer company. Unfortunately, the equipment used varied greatly in its cross-country mobility and reliability. The vehicles were a mixture of tracked and wheeled, experimental and well-developed equipment that could not move together except at very slow speeds. As a result, some officers of the Royal Tank Corps decided that the other arms were incompatible with armored operations and focused their attention on almost pure tank formations.

The British War Office dissolved the Experimental Mechanized Force in 1928 for a variety of factors, including budgetary restrictions and the opposition of some military conservatives. This force did, however, provide the basis for Col. Charles Broad to produce a new regulation, Mechanized and Armoured Formations, in 1929. This regulation was a great advance in describing the roles and missions of separate armored formations, but it also

reflected the pure-tank attitude that was becoming common in the Royal Tank Corps. Even when Broad proposed a Royal Armoured Corps that included tanks, mechanized cavalry, and mechanized infantry, he explicitly excluded artillery and engineers.¹¹ Still, Broad recognized different models of armored vehicle and different roles for them. In particular, the standard "mixed" tank battalion of an independent tank brigade was a combination of three different types of vehicle. Within each company, seven light tanks would reconnoiter the enemy positions and then provide fire support for five medium tanks that actually conducted the assault. In addition, two "close support tanks"--really self-propelled howitzers or mortars--would provide smoke and suppressive fire for the assault.¹² Since in practice the "light tanks" were often small armored personnel carriers, the parallel with more recent American armored cavalry should be obvious.

British armored theorists did not always agree with each other. Basil Liddell Hart, a noted publicist of armor, wanted a true combined arms force with a major role for mechanized infantry. Fuller, Broad, and other officers were more interested in a pure-tank role, in part because they experienced difficulty cooperating with the other arms. G. L. Martel, one of the most innovative theorists and tank designers of the period, was fascinated with the idea of using extremely small armored personnel carriers, capable of transporting one to three men and a machine gun, to assist the infantry in its attacks. Unfortunately, the machine gun carriers designed at Martel's instigation participated in experiments both as reconnaissance vehicles and infantry carriers, and proved inadequate for either function.¹³ Not until the eve of World War II did the British develop a reliable machine gun carrier, and even then it was dispersed in small numbers within infantry battalions that attacked on foot.

Despite these differences of opinion, the next step in developing the role of armor was to form an independent mechanized force of division size. This was undertaken as an experiment in 1934, using Col. Percy Hobart's 1st Tank Brigade, a newly formed unit of the type envisaged by Broad, and Maj. Gen. George Lindsay's partially mechanized 7th Infantry Brigade. Unfortunately for the British, personality differences, lack of training, and artificial restrictions from the umpires turned the resulting exercise into a disaster. General Lindsay, one of the few senior officers who was genuinely committed to the development of a combined arms mechanized division, was so discredited by the fiasco that he ceased to have any influence over policy.¹⁴

Instead, the conservative Chief of the Imperial General Staff, Gen. Sir Archibald Montgomery-Massingberd, chose to create a permanent "Mobile Division" by mechanizing large portions of the British cavalry. The Mobile Division authorized in December 1937 consisted of two armored cavalry brigades, each almost entirely mounted in light tanks and armored cars, plus one tank brigade, two mechanized infantry battalions, and limited amounts of artillery, engineers, and support units. Such a formation was quite appropriate for performing the functions of reconnaissance and security, whether in the empire or on the continent. It did not, however, integrate the different arms at a sufficiently low level to fight in fluid operations as an armored formation against a sophisticated enemy. In most cases, reconnaissance, medium armor, infantry, and artillery were under separate brigade-level commands. With various minor changes, this mobile division became the 1st Armoured Division, which sacrificed itself piecemeal in France in 1940.¹⁵ A second mobile division formed in Egypt, providing the basis for later British operations there.

There were also problems with equipment. The Royal Tank Corps had to make do with the same basic tanks from 1922 until 1938, despite frequent changes in design and technology. Almost the only improvement came in the period 1930-32, when radio communications changed markedly. Until this time, each vehicle crew had to tune its radio by hand to a common frequency, and the motion of a moving tank could easily throw the radio off that frequency. Colonel Broad instigated a series of developments that eventually provided crystal-controlled, preset frequencies. The complexity and expense of such equipment, however, made distribution of radios down to individual tanks very slow.¹⁶ Only such radios could allow a commander to control his rapidly moving units while observing and leading from the front.

During the 1930s, the confusion about tank roles combined with frequent changes in the defense bureaucratic structure to thwart good armored vehicle design.¹⁷ Generally speaking, British armored vehicles tended to maximize either mobility or protection. Both the cavalry and the Royal Tank Corps wanted fast, lightly armored, mobile vehicles for reconnaissance and raiding--the light and medium (or "cruiser") tanks. On the other hand, the "army tank battalions" performing the traditional infantry-support role required extremely heavy armored protection in order to advance successfully against prepared enemy defenses that included antitank guns.

As a consequence of these two doctrinal roles, firepower was neglected in tank design. As late as 1937, the very thin armor on most tanks of the world made armor-piercing machine guns, or at most a 20-mm cannon, seem entirely adequate for antitank

defense. In fact, many soldiers believed that the tank was more vulnerable than ever because infantry had acquired some antitank training and equipment. Anticipating improvements in tank armor, the British standardized on a two-pounder (40-mm) antitank gun. This was also the standard weapon mounted in most British tanks well into World War II. Yet such a weapon could only penetrate German armor of 1939-42 design at 500 or fewer meters and was not designed to fire high explosive ammunition to suppress enemy infantry and towed antitank gun fire. Although Hobart called for a six-pounder (57-mm) tank gun in 1938, this was not stated as a formal requirement for tank design until after the fall of France in 1940.¹⁸ Even then, most turrets designed for the two-pounder were too small to be upgunned.

While Britain drifted in the area of mechanization, developments in the more traditional arms were equally mixed. Cavalry, as already noted, in essence merged into the mechanization process, although too late to learn all the mechanical and tactical differences between horses and light armor. Infantry was saddled with inappropriate weapons throughout the 1920s. It had no useful antitank capability, and the Lewis machine gun was really too heavy to maneuver as a squad weapon. Between 1936 and 1939, new equipment and organization finally restored the firepower and mobility of British infantry, but at a price. The excellent Bren light machine gun, with its accompanying small armored carrier, was a significant advance. Each squad in a rifle platoon had a dismounted Bren gun, and the platoon had a two-inch smoke mortar and a caliber .55 Boyes antitank rifle. The battalion consisted of four rifle companies, plus a headquarters with platoons of Bren gun carriers, two-pounder antitank guns, three-inch mortars, and anti-aircraft machine guns. Heavy machine guns and 4.1-inch mortars were centralized into separate support battalions. The result was that the infantry battalion was much lighter and more mobile than it had been, but it had a somewhat reduced firepower and only limited antitank capability. On the eve of World War II, the inadequacies of the Boyes rifle rapidly forced the artillery to assume primary responsibility for antitank defense.¹⁹ The artillery had indeed developed excellent pieces that had an additional antitank capacity. In the process, however, the British had largely neglected the scientific procedures of indirect fire developed during World War I. Only the School of Artillery continued to teach these techniques, so that a few officers were familiar with them. In 1939, the prejudice of many artillerymen against artillery survey techniques led to a reorganization that briefly eliminated survey parties from artillery headquarters.²⁰

Thus, by 1939 the British Army had lost much of its pioneering advantage in both equipment and technology. Outside of the infantry battalion, cooperation between different weapons systems and arms was little better than it had been in 1914.

Germany: "Strike Concentrated, Not Dispersed"²¹

France, Britain, and the United States, the victors of 1918, had a natural tendency to employ at least some of the materiel and doctrine of 1918 during the immediate postwar years. A defeated Germany, by contrast, had every reason to embrace new tactics and weapons.

Even if it wished to, Germany could not reproduce the mass armies and static defenses of 1914-18. The Treaty of Versailles limited the German Army to 100,000 long-tour professional soldiers, without reserves except for the paramilitary police forces. The same treaty forbade Germany to possess tanks, poison gas, combat aircraft, and heavy artillery. Paradoxically, for the Germans this prohibition may have been a blessing in disguise. The German defense budget and tactical thought were less restricted to, or dependent on, the technology of 1918 than were other budgets and armies. Instead, planners could study concepts and then develop the equipment to make those concepts reality. Doctrine led technological development, in contrast to the situation in other armies. In those instances where field trials had to be conducted, the Germans used mock-ups, or tested equipment and concepts in secret within the Soviet Union.* This is not to say that German planners started from scratch. No army can completely escape its past, but Germany certainly had an advantage over the victorious Allies.

Since the 1860s, the German tradition of tactics and operations had favored outflanking and encircling the enemy or, if that failed, breaking through to disrupt his organization. This was in contrast to the frontal battles of attrition that most of Germany's enemies had fought in World War I. This German tradition meant two things. First, unlike the French and British, who had learned to attack on a broad front in order to protect their flanks, the Germans believed in concentrating all their resources on a relatively narrow front for breakthrough.²² Second, this concentration of forces required the careful integration of all weapons and arms at battalion

*As the two outcast nations of Europe during the 1920s, Germany and the Soviet Union had much in common. Their secret exchange of military knowledge continued until Hitler came to power.

level or below to overcome the enemy's defenses. The infiltration tactics of 1917-18 reflected this viewpoint and were retained after the armistice. Despite the restrictions of the Versailles Treaty, the 1921 German Regulation on Command and Combat of the Combined Arms included not only the infantry assault battalion and the carefully planned artillery and preparations of 1918, but also close air support, gas warfare, and tanks in an infantry-support role.²³ Again, the Germans were free to develop doctrine on the basis of their experience but without being restricted to specific technology. Despite later manuals, this sophisticated regulation remained the basis of German doctrine between the wars.

Another part of the German military tradition was decentralized execution. German commanders moved forward to observe and make tactical decisions for themselves. This enabled them to communicate their decisions to subordinates much more rapidly than was possible from a command post in the rear. This decentralization was facilitated by a mutual understanding among German leaders, an understanding based on common doctrine such as the Command and Combat of the Combined Arms. Aware of both a commander's intention and the common doctrine, subordinate leaders could execute that intention in accordance with that doctrine and, thereby, reduce the need for detailed instructions from higher echelons. This decentralization and rapidity of decision making were ideally suited to any form of fluid combat, including mechanized operations.

In retrospect, it might seem inevitable that, once combined with the German experience of the psychological effects of tanks during World War I, the German infiltration tactics, the belief in massing on a narrow front, and decentralized execution would lead to blitzkrieg. In fact, however, the German Army did not wholeheartedly accept the concept of mechanized blitzkrieg until the defeat of France in 1940. Prior to that time, the majority of senior German commanders apparently regarded mechanization as a useful but very specialized tool that would not replace ordinary infantry divisions. In thinking this, they shared much of the traditional viewpoint that characterized their counterparts in Britain, France, and elsewhere.

Among the German proponents of mechanization, Gen. Heinz Guderian was probably the most influential. Like Percy Hobart in Great Britain, Guderian had considerable experience with the early military use of radio communications. This had two effects upon his later career. First, Guderian's 1914 service with radiotelegraphs in support of cavalry units led him to insist on a radio in every armored vehicle, a major advantage in command and control. By contrast, the French and others often had radios only for the command tanks and depended on hand signals or flags to maneuver small units. More generally, Guderian's early

service taught him the difficulties of integrating new doctrine and equipment and then overcoming institutional resistance to that doctrine and equipment.²⁴ As a staff officer concerned with motorized transportation, Guderian gained further experience from his first studies of mobile warfare. The small size of the German Army in the 1920s forced it to increase its mobility in order to shift limited forces rapidly. Guderian was one of a group of officers who studied the use of motor vehicles to achieve this mobility. To a certain extent, the German theorists had to rely on British experience and regulations to learn about equipment that Germany did not possess in large numbers. Yet, the German concept of mechanized warfare developed almost independently of such trends in Britain. By 1929, when many British students of armor were tending towards a pure armor formation, Guderian had become convinced that it was useless to develop just tanks, or even to mechanize parts of the traditional arms. What was needed was an entirely new mechanized formation of all arms that would maximize the effects of the tank. Only such a formation could sustain mobile warfare, whether offensive or defensive.²⁵

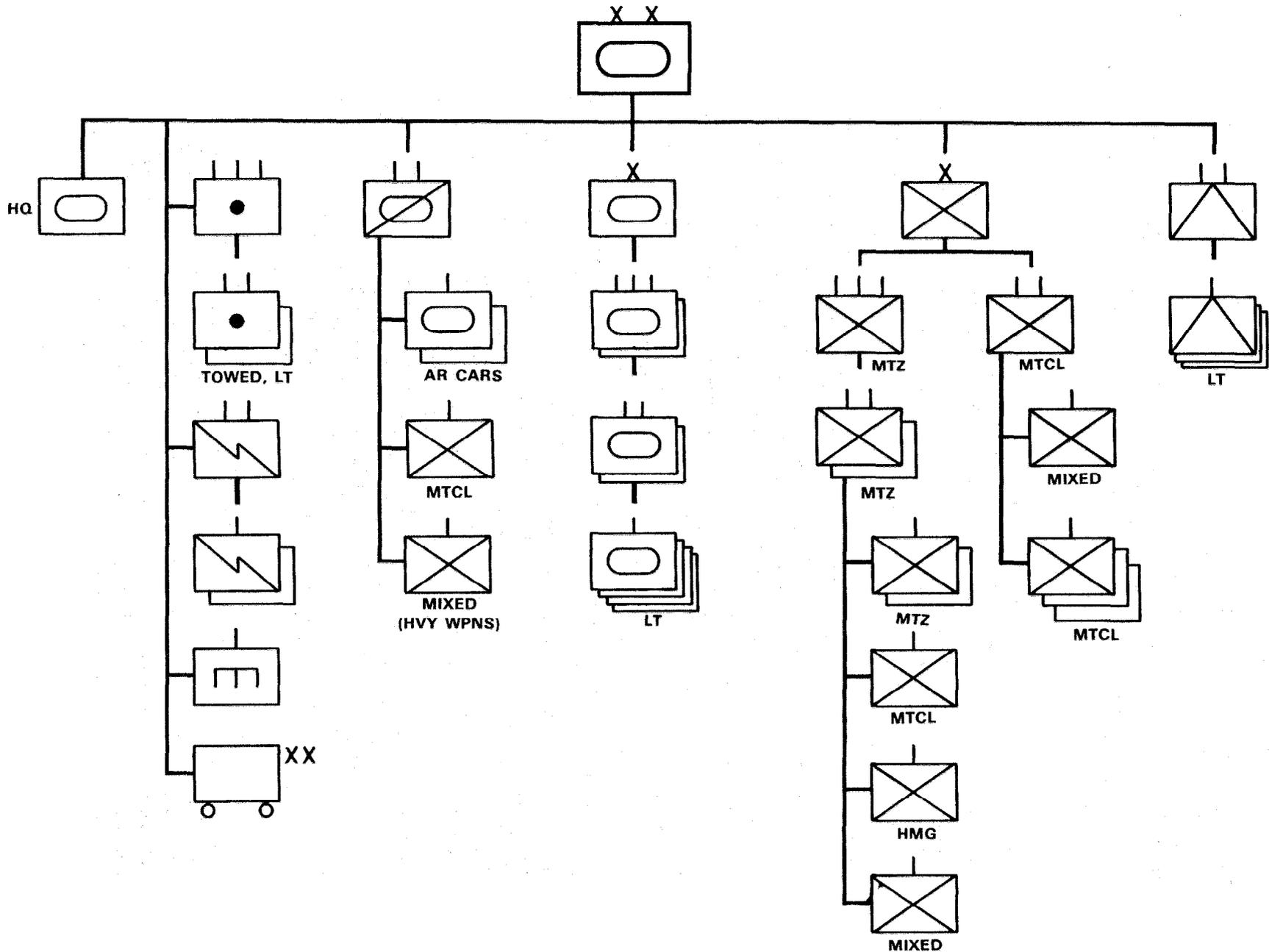
The general belief among military theoreticians that antitank defenses were becoming stronger did not deter Guderian. Unlike most advocates of armor, he considered antitank weapons to be an essential part of the mechanized combined arms team, rather than the defender of the traditional arms against the new weapons. Most early tanks were too small and unstable to carry accurate, high-velocity antitank guns. By contrast, the towed antitank gun was specially designed for maximum effectiveness against armor, and its small silhouette made it difficult to detect and engage. The German armored units trained to avoid fighting other tanks or antitank guns, and instead to exploit in areas of little or no resistance. In the event of tank-versus-tank combat, the German tanks might withdraw temporarily, luring the enemy into a hidden screen of antitank weapons that had deployed behind the German spearhead. To do this, tanks needed reconnaissance units to lead the way and screen the flanks of the advance, with combat engineers to sustain the mobility of the mechanized force. Motorized or mechanized infantry and artillery were necessary to reduce bypassed centers of resistance, to support tanks in the attack, and to hold areas seized by such attacks. The entire force required support units that could keep up with a rapid advance.

In 1931, Guderian became commander of the 3rd Motor Transport Battalion. Using dummy equipment because of the limitations of the Versailles Treaty, this battalion was actually an experimental "mechanized" force consisting of one company each of motorcycles, armored cars, tanks, and antitank guns. A similar small-scale demonstration, using some of the first light tanks

produced in Germany, impressed Hitler in 1934.²⁶ That same year, experimental maneuvers for a full panzer division took place, and in 1935 Hitler formed the first three such divisions on a permanent basis (see Figure 5). As in the other armies, Germany's first effort at armored organization included a tremendous number of tanks (561 per division).²⁷ Otherwise, this organization showed considerable balance in numbers and types of weapons. Moreover, regardless of the paper organization, the brigade and regimental headquarters were trained to control cross-attached units and weapons systems. Such a system required considerable training and put great stress on the maintenance and logistical support of the cross-attached elements, but it enabled the panzer division to combine different weapons systems as needed.

Guderian did not, however, succeed without opposition and difficulties. The other branches of the German Army resisted the creation of this new arm and demanded a share of mechanization and motorization for themselves. During the later 1930s, the Chief of the German General Staff directed the motorization of all antitank units and one engineer company in all infantry divisions, plus complete motorization of four selected infantry divisions, at a time when the panzer divisions were still short of transportation. In 1937-38, two separate tank brigades were formed for infantry support, isolated from the other arms. At the same time, four "Light Divisions," based on cavalry units in most cases, absorbed more motorized and mechanized equipment. The actual composition of these units varied, but the most common pattern was an armored reconnaissance regiment, two motorized infantry regiments, one light tank battalion, and two towed howitzer battalions. A frustrated Guderian found himself shunted aside as "Chief of Mobile Troops," with little or no control over the motorized infantry and light divisions.

Nor were the German tanks up to the standards of Guderian's concept. Despite Hitler's support for panzer units, those units had to compete for production capacity and new weapons not only with the rest of the expanding German Army, but also with the German Air Force. Hitler placed first priority on the Luftwaffe because of the intimidation value that air power gave him when dealing with the rest of Europe. Under the circumstances, Guderian had to settle for tanks that were not completely battleworthy. The Mark I was really a machine gun-armed tankette, derived from the British Carden-Loyd personnel carrier. The Mark II did have a 20-mm cannon, but little armor protection. These two vehicles made up the bulk of panzer units until 1940.²⁹ Their value lay not so much in their armor and armament, but in the fact that they were available early, in considerable numbers, and with radio communications. This



allowed the new panzer force to conduct extensive training, establish battle procedures, identify and solve problems, and develop changes in organization and equipment. By 1939, the panzer divisions were not completely ready, but they had gone through their first, most necessary stages of organization and training. Such an advantage was denied to most of Germany's opponents.

Another German advantage was in the field of close air support of ground operations. When the Luftwaffe was established in 1933, most of the higher commanders were World War I aviators and others who had served in the ranks of the 100,000-man army imposed by the Versailles Treaty. Initially, the Luftwaffe, like other air services, favored missions such as strategic bombing and air superiority to the neglect of supporting ground forces. The experience of the Spanish Civil War (1936-39) changed priorities to some extent. The German force sent to aid Franco used a limited number of obsolete fighters in a ground-attack role, with considerable effect. These experiences provided the impetus for Germany to create five ground-attack aviation groups in the fall of 1938. Ernst Udet, the chief of the Luftwaffe's development branch after 1936, persuaded his superiors to produce a limited number of close support dive-bombers patterned after the U.S. Navy's Curtiss Helldiver. The resulting JU-87 Stuka dive-bombers equipped four of the five ground-attack groups during 1939. Dive-bombers were extremely accurate and demoralized ground defenders rapidly. In addition, in both Spain and Poland a very small number of air liaison detachments were attached to the infantry corps and armored division headquarters making the main attack. These detachments could pass air-support requests directly to the Luftwaffe and could monitor in-flight reconnaissance reports. They could not, however, actually guide the aircraft onto targets without departing the ground headquarters to which they were attached, nor did they have training for such a role. In any event, the handful of dive-bomber groups and air liaison detachments was available only to the army units at the point of main effort; all other army headquarters had to submit preplanned requests that might or might not be honored. In 1939, on-call air support against targets of opportunity was well in the future for most of the German Army.³⁰

Thus the tradition of combined arms integration was continued and updated in the German Army between the world wars. Guderian was tactically incorrect when he denied the need to provide armor and motorized equipment for the other elements of an army that remained essentially foot-mobile and horse-drawn. His determined opposition, however, did enable Germany to keep the majority of its mechanized assets concentrated in combined arms mechanized

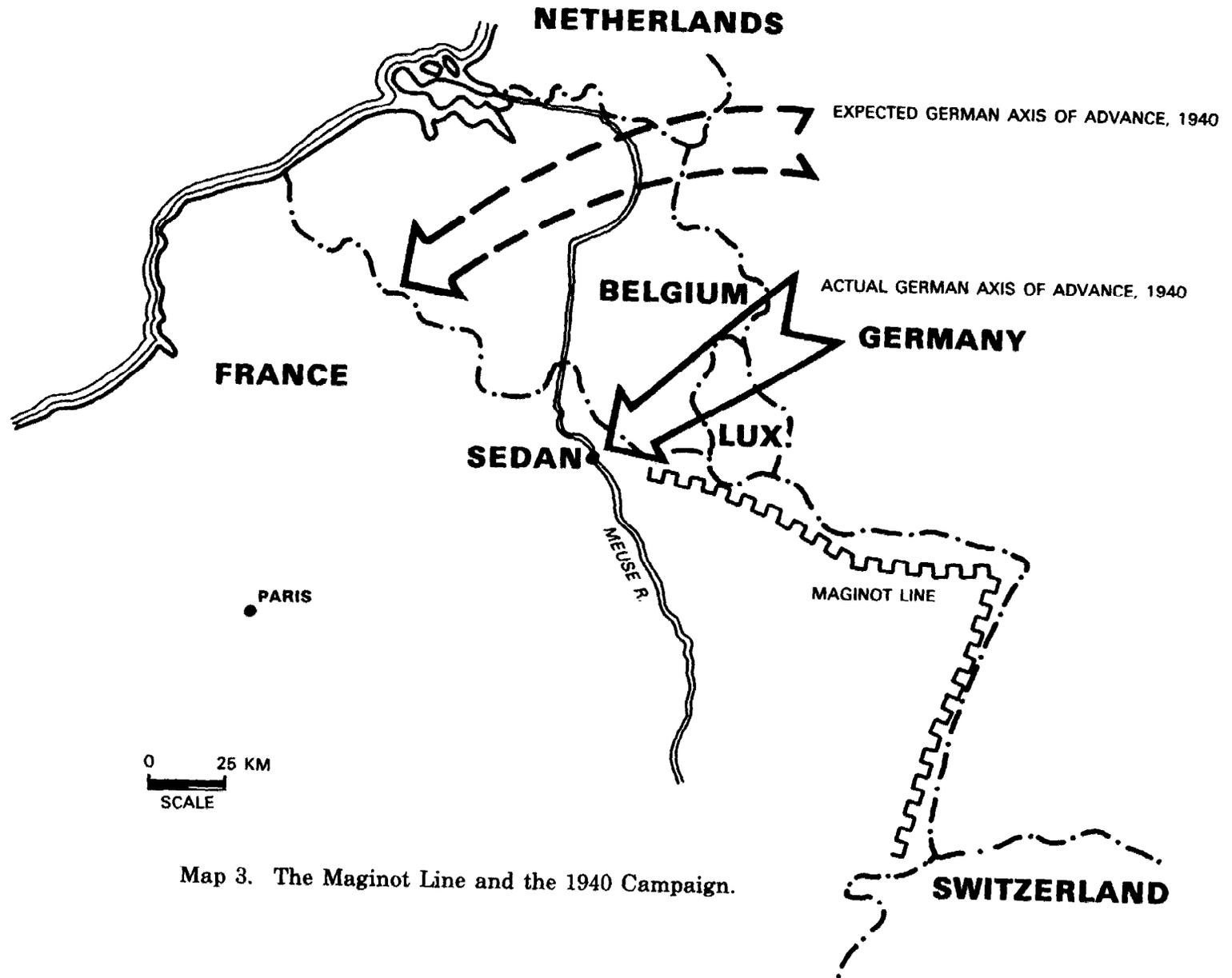
units, despite the equipment given to other branches. In September 1939, twenty-four out of thirty-three tank battalions and 1,944 out of 3,195 tanks were concentrated in the six panzer divisions.³¹ The contrast with other countries, where large numbers of tanks were dedicated to infantry support and cavalry roles, is striking.

France

The existence of a 100,000-man professional German Army forced the French to develop plans to counter a sudden invasion by that army. The postwar French Army was huge, but ill prepared to stop a surprise attack by even the small German force. It was basically a cadre for reservists, who required weeks or even months to mobilize. After 1918, French war weariness eliminated the highly developed mobilization system of 1914 and, in 1928, reduced conscripted service to a bare twelve months of training.

To protect itself from a sudden attack by the small German Army, France chose to construct a sophisticated version of the defenses that had apparently worked so well at Verdun. The Maginot Line (Map 3) was a string of self-contained concrete forts with gun turrets. It was built between 1930 and 1936 in Northeastern France; its function was to protect the land regained in 1918 and to force any German invasion to pass through Belgian territory before reaching France. This extra distance would give France time to mobilize.

The Maginot Line has frequently been criticized because, in retrospect, it appeared child's play for the Germans to outflank these fortifications. Yet, quite apart from the political reality that France could not abandon Belgium by building a major wall between the two countries, the Maginot Line concept was much less defensive than popular wisdom suggests. In addition to providing security during mobilization and protecting critical areas near the French frontier, the Maginot Line was a secure anchor, a base around which the mobile field forces of the French Army would maneuver.³² More specifically, in the later 1930s both France and Britain expected that any future war with Germany would be a repetition of 1914, with Germany advancing through all of Belgium and possibly the Netherlands as well. Because Belgium was neutral, France and Britain could not enter that country to help defend it until the Germans had already invaded. Thus, the majority of French and British mobile forces planned to make a headlong rush into Belgium. The surprise to the Allies in 1940 was the German penetration through Luxembourg towards Sedan, a penetration that cut the hinge between the mobile forces and the Maginot Line.



Map 3. The Maginot Line and the 1940 Campaign.

Moreover, despite the intent of the Maginot Line, its practical effects were much less positive for French defense. The tremendous expense of fortress construction restricted the depth of the fortifications and even the size of armament of those forts. Only a few positions included the lavishly constructed works shown in contemporary photographs. In case of war the line had to be supplemented by field fortifications and troops deployed between the fixed positions. More importantly, once built the Maginot Line had a negative psychological effect on the politicians, if not on the commanders. The apparently invincible defensive strength of the Maginot Line reinforced the general left-wing political belief that France should avoid any aggressive actions and be content to defend its frontiers.

This defensive orientation influenced not only national budgets but French military doctrine, at least immediately after 1918. More than any other participant in the First World War, France retained the positional warfare concept in its postwar regulations. Under the influence of Marshal Philippe Pétain, the French Army produced the Provisional Instructions for the Tactical Employment of Larger Units (1921). This regulation was not entirely defense-oriented, but to minimize casualties it did insist on careful, methodical preparations before attacking. Within the carefully coordinated circumstances of a set-piece offensive, battle would involve all arms to assist the infantry:

The infantry is charged with the principal mission in combat. Preceded, protected, and accompanied by artillery fire, aided where possible by tanks and aviation, it conquers, occupies, organizes, and holds the terrain.³³

This conception had two flaws. First, such a meticulously planned, centrally controlled operation was unable to react to sudden changes. The German offensives of 1918 had already demonstrated that any enemy action that disrupted the defender's linear deployments and lockstep planning would catch the French headquarters off guard, unable to reorganize a defense against a highly mobile attacker.

More generally, the French doctrine viewed combined arms as a process by which all other weapons systems assisted the infantry in its forward progress. Tanks were considered to be "a sort of armored infantry," subordinated to the infantry branch.³⁴ This at least had the advantage that armor was not restricted purely to tanks. The French cavalry experimented extensively during the 1920s with armored cars and ultimately half-tracks. These half-tracks sometimes formed combat teams with armored cars, towed artillery, motorcycles, and light tanks carried on trucks until contact was made.³⁵ In fact, the French half-tracks may

well have been the models for later German and American infantry carriers. Still, the subordination of tanks to infantry impeded the development of roles for armor other than close infantry support. Moreover, while half-tracks might be useful in colonial wars or for reconnaissance tasks, infantry still walked in the deliberate assault. Armor was tied to the rate of advance of foot-mobile infantry. The alternative of finding ways to increase the mobility and protection of the infantry in order to keep pace with the tanks was rarely considered. The slow speed of the World War I vintage FT tank, which equipped most French armor units throughout the 1920s, reinforced this attitude.

Not all Frenchmen held this view. Gen. Jean-Baptiste Estienne, commander of the World War I French tank corps before it was disbanded, was quite farsighted in his concept of mechanized warfare. In 1919, Estienne submitted a "Study of the Missions of Tanks in the Field" to Petain's headquarters. This remarkable document explained the need to provide armored, tracked vehicles not only for tanks, but also for reconnaissance, infantry, artillery, and even battlefield recovery teams. Estienne's vision of this massed force, supported by air bombardment and attacking in-depth against a narrow enemy front, closely resembled the best mechanized ideal of World War II. In 1920, Estienne proposed a 100,000-man armored army with 4,000 tanks and 8,000 other vehicles. Instead of rejecting the use of infantry, he argued that armored infantry would again be able to attack using its organic weapons.³⁷ Estienne's concept was not only radical militarily, but also seemed too offensively minded, too aggressive to be acceptable to French politicians. Nevertheless, Estienne remained Inspector of Tanks until his retirement in 1927.

Despite the restrictions imposed by the Great Depression and by the enormous cost of the Maginot Line, Chief of Staff Maxime Weygand took significant steps towards motorization and mechanization during the early 1930s. Five and ultimately seven infantry divisions became motorized, and one brigade in each of four light cavalry divisions was equipped with half-tracks and armored cars. In 1934, Weygand continued the trend towards armored cavalry by forming the first "light mechanized division" (Division Légère Mécanique, or DLM, shown in Figure 6). This division, with its combination of reconnaissance, light tanks, trucked infantry, and towed artillery, was remarkably similar to the German panzer division being developed at the same time. Because Weygand was a cavalryman, and because it was politically easier to justify a defensive covering force than an "offensive" armored unit, the four DLMS ultimately formed by France all received standard cavalry missions of reconnaissance and security, rather than mechanized main battle tasks.³⁸

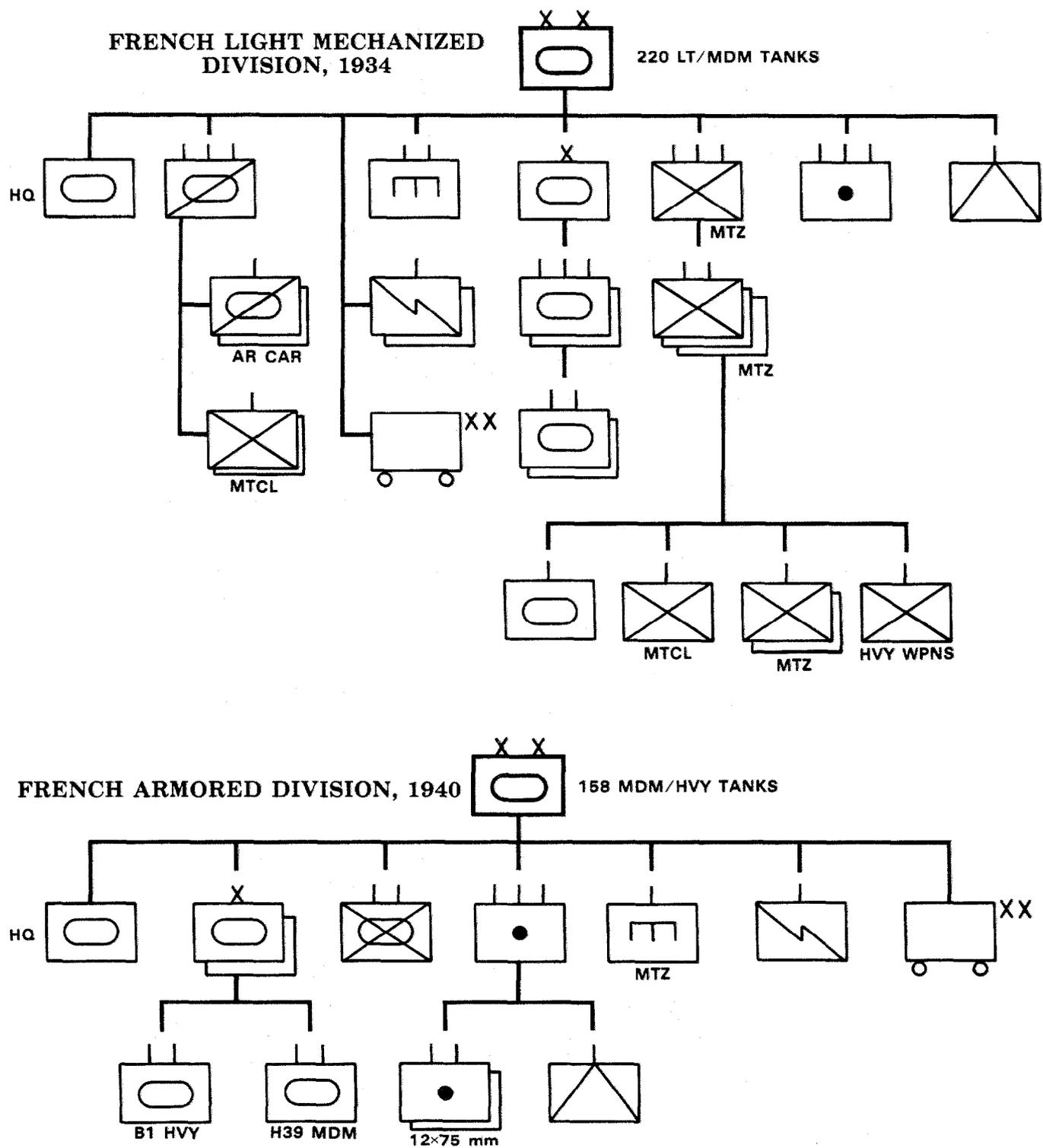


Figure 6. French Light Mechanized Division, 1934, and Armored Division, 1940.

Just as the French Army was cautiously moving forward in the area of mechanization, its development was almost aborted by the writings of Charles de Gaulle. In 1934, Lieutenant Colonel de Gaulle published Towards the Professional Army. This call for a 100,000-man armored army was based heavily on Estienne's work. De Gaulle's book was hardly innovative in terms of doctrine and organization in that it envisioned a pure armor brigade operating in linear formation, followed by a motorized infantry force for mopping-up operations. The real problem was political. In a nation that was extremely pacifistic and dedicated to the doctrine of the citizen soldier, de Gaulle was advocating an aggressive, professional standing army of technicians. His "instrument of repressive and preventive maneuver"³⁹ might well be used to start an offensive war with Germany or to support a military coup d'etat in republican France.

De Gaulle's sensational book not only jeopardized the more gradual efforts of Weygand, but also set extremely high standards for what constituted an armored division. In 1936, France belatedly decided to produce armor and other equipment in larger quantities, including 385 B-1 bis tanks. The B-1 bis, developed by Estienne in the early 1920s, was still one of the best tank designs in the world fifteen years later. It had sixty millimeters of frontal armor in a carefully cast hull, hydromatic transmission, and other advanced features. It was limited by the small size of its turret, where one man had to be both tank commander and gunner for a 47-mm gun, but a lower-velocity 75-mm gun was mounted in the hull. The B-1 bis was an excellent weapon that caused the Germans much difficulty in 1940. Yet, given the fine craftsmanship involved in B-1 bis production and the weakened state of France's industry, it took years to produce sufficient tanks to organize an armored division on the pattern desired by Estienne and de Gaulle. Even after the war started, France could never produce more than fifty of these tanks per month, and the rate prior to 1939 was much lower.⁴⁰ As a result, France did not form its first two armored divisions (Division Cuirassée, or DCR, as shown in Figure 6) until after the war began and, even then, had to greatly reduce the authorized number of heavy tanks in each division. The resulting unit was primarily a collection of tanks for an armored breakthrough; it lacked sufficient reconnaissance, antitank, infantry, artillery, and engineer support. Similar problems plagued the production of other tanks and military equipment, so that French troops rarely had the time for realistic training and experimentation that the Germans had achieved before 1939. The French regulation for large armored unit tactics was not issued until March 1940, a few weeks before the German invasion of France.⁴¹

Despite such limitations, France slowly modernized during the 1930s. The 1921 Provisional Instructions gave way to a much more sophisticated regulation in 1936. The new Instructions recognized the major changes in warfare, including fortified fronts such as the Maginot Line, motorized and mechanized units, antitank weapons, increased air and antiaircraft involvement in combat, and improved communications. The regulation no longer classified tanks by size, but rather designated the particular mission they would perform at any given time. Tanks could either accompany infantry, precede infantry by bounds to the next terrain feature, or operate independently, especially after the enemy's defenses had already been disorganized. The 1936 regulation, however, still insisted on the primacy of infantry, the careful organization of artillery, and the methodical advance of all elements in accordance with an elaborate plan. As in Britain, French air support to ground forces consisted primarily of reconnaissance in the battle area, with bombing only outside the range of artillery. The regulation repeatedly emphasized the need for "defense without thought of retreat," which tended to mean rigid orientation toward the terrain and the enemy to one's front, rather than toward maneuvering to deal with a threat to the flank or rear. References to antitank defense-in-depth also appeared frequently in this regulation, but France lacked the troops to establish such a defense in 1940. Finally, because of the possibility of enemy signals intelligence, radios were only to be used when no other means of communication were available. In any event, at least some French tank radios were meant only for short-range communications with dismounted infantry in a deliberate attack and were consequently useless in mobile operations. Thus, most of the French command and control still moved at the pace of communications in World War I.⁴²

France entered World War II with a militia army that would require months to organize and train, and with new mechanized formations and modern equipment that had been fielded too late for proper testing, evaluation, and training. Like those of the British, French armored units were specialized either for cavalry missions or deliberate breakthrough attacks; they were not balanced for all types of mobile operations. Given these limitations, the French doctrine of slow, methodical offensive action appeared as the only course that would allow them to attack at all. Unfortunately, the Germans did not wait for the French to plan and execute such attacks.

The Soviet Union: "Deep Battle"⁴³

The Soviet Union's military development after World War I differed from that of the rest of Europe for two reasons. First, the Red Army was created in 1918 after the Bolshevik revolution

and lacked the traditions and training of other major armies. Many of the new Red commanders had been noncommissioned or commissioned junior officers during World War I, but few trained senior officers of the Tsarist Army remained with the new regime. Even those who did remain were, with some exceptions, suspected of anti-Bolshevik sympathies. As a result, the Red Army was open to change, unhampered by excessive traditions or past habits. It was also subject to the blunders of ignorance. Second, the Russian Civil War of 1918-21 was markedly different from most of the European campaigns of World War I. Because of the vast distances and understrength armies involved in the Civil War, penetration and encirclement were no longer difficult, and fluid maneuver was the rule. The elite of the Red Army by the end of the Civil War was Marshal S.M. Budenny's 1st Cavalry Army, which had patterned its encirclements and pursuits after the best Tsarist cavalrymen. The veterans of this army received the patronage of Joseph Stalin, who had been the commissar of the next higher headquarters. As a result, many officers from this army rose to senior positions before and during World War II.⁴⁴

Like Hitler's Germany, but unlike France and Britain, the Soviet Union was openly interested in offensive warfare as a means of spreading its political doctrines. As a practical matter, Stalin chose to concentrate on developing the Soviet Union before expanding into Europe. Still, the Red Army could expect that any future war would be offensive, using weapons that democratic societies abhorred as too aggressive. This offensive orientation was reinforced by the close relationship that existed between the Red Army and the German Army from 1923 to 1932. Soviet officers studied in Germany, while the Germans secretly manufactured and tested tanks, aircraft, and poison gas in European Russia. Soviet doctrine, however, appeared to be largely independent of similar developments in Germany; Soviet concepts were official policy long before Guderian gained even partial approval from his government.

During the course of the 1920s and early 1930s, a group of Soviet officers led by Marshal Mikhail Tukhachevsky developed a concept of "Deep Battle" to employ conventional infantry and cavalry divisions, mechanized formations, and aviation in concert. These efforts culminated in the Field Regulations of 1936. Instead of regarding the infantry as the premier combat arm, Tukhachevsky envisioned all available arms and weapons systems working together in a two-part battle. First, a massed, echeloned attack on a narrow front would rupture the defender's conventional infantry-artillery-antitank defense. The attacker's artillery and mortars would suppress defending artillery and especially defending antitank guns. Moving behind the artillery barrage and a few meters in front of the infantry, the tanks could safely crush wire, overrun machine gun posts, and reduce

other centers of enemy resistance. Once the enemy's forward defenses were disrupted, accompanying tanks would not be tied strictly to the infantry rate of advance, but could take advantage of local opportunities to penetrate and attack enemy reserves, artillery, headquarters, and supply dumps. This action would duplicate on a smaller scale the second part of the battle, which was to disrupt and destroy the enemy by deep attacks. "Mobile Groups," composed of cavalry, mechanized formations, or both, would exploit their mobility advantage to outflank the enemy or develop a penetration in order to reach the enemy rear areas. The object was to attack the entire depth of the enemy defenses simultaneously, with conventional frontal attacks, long range artillery fires, deep penetrations by mobile forces, and bombing and parachute attacks of key points. Smoke and deception operations would distract the enemy from the attacker's real intentions.⁴⁵

This remarkably sophisticated doctrine was backed up by a force structure that, by 1937, was well on its way to implementing Tukhachevsky's concepts. Using the expanded production facilities of the Soviet government's first Five Year Plan with design features taken in part from the American inventor Walter Christie, the Soviets produced 5,000 armored vehicles by 1934.⁴⁶ This wealth of equipment enabled the Red Army to create tank organizations for both infantry support and combined arms mechanized operations. Virtually all rifle divisions had a tank company or battalion attached to them, with an entire regiment of 190 or more tanks for each of the horse cavalry divisions. Beginning in 1930, the Red Army experimented with integrating all arms into mechanized functional groups at battalion, brigade, and higher levels. Although organizations changed frequently as equipment and tactical techniques evolved, the 1935 mechanized "corps" was typical of these developments (Figure 7). The four corps organized under this concept were really small armored divisions (the Soviets frequently used the terms "corps" and "brigade" to designate experimental units of division and regimental size, respectively). These mechanized corps were extremely armor-heavy, but nevertheless integrated the essential combat arms at a relatively low level. The trend during the later 1930s was for these corps, redesignated "tank corps" in 1938, to become increasingly large and armor-heavy.

This Soviet force structure had its problems, of course. To begin with, despite the massive industrial support of the Soviet Union, the armored force was so ambitious that not all units could be fully equipped. Soviet historians have criticized the separation of available equipment into infantry-support and independent formations under these circumstances.⁴⁷ More

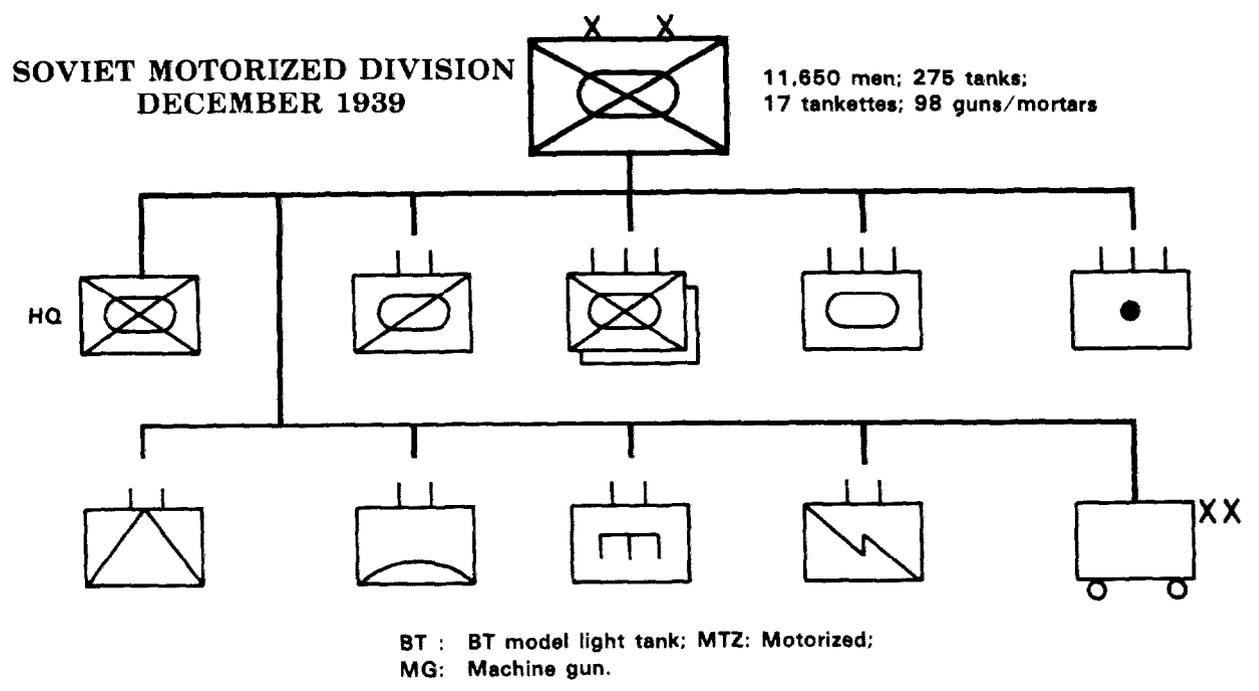
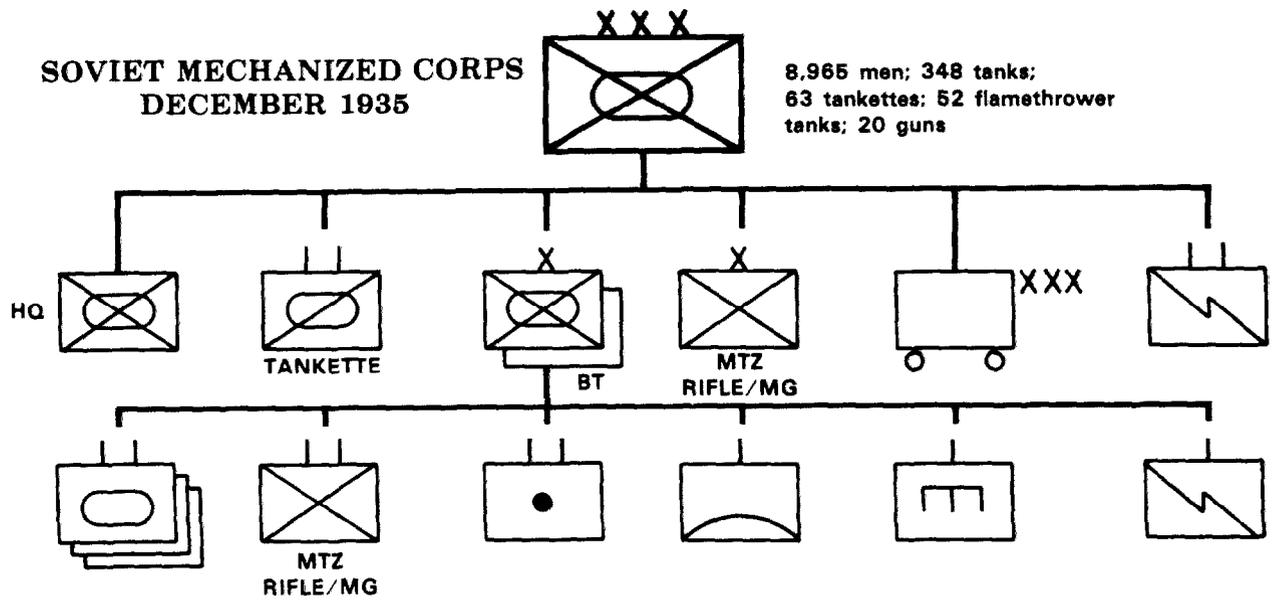


Figure 7. Soviet Mechanized Corps, December 1935, and Motorized Division, December 1939

specifically, the average Soviet citizen had little experience with motor vehicles, so that maintenance was often a problem, particularly as the vehicles wore out. Soviet radios were notoriously unreliable, making command and control of this mass of moving vehicles difficult. Despite frequent major exercises during the mid-1930s, the Soviet armored force needed several more years of experimentation and training before it could realize its full potential.

It never got that time. On 12 June 1937, the Soviet government executed Tukhachevsky and eight of his high-ranking assistants, as Stalin shifted his purge of Soviet society against the last power group that had the potential to threaten him, the Red Army. In the ensuing four years, the Soviet government imprisoned or executed at least 20 percent of the officer corps, including a majority of all commanders of units of regimental size or larger. Thus, at the same time the Red Army was expanding because of the threat from Nazi Germany and Imperial Japan, it was losing its most experienced planners and leaders. The politically reliable survivors were promoted into positions far above their previous training and experience, with disastrous effects on unit development and tactics.⁴⁸

At the same time that Tukhachevsky's thought was under suspicion, the Soviet experience in the Spanish Civil War caused the Red Army to reassess mechanization. Dimitri Pavlov, chief of tank troops and one of the senior Soviet commanders to serve in Spain, came back with an extremely pessimistic attitude. The Soviet tanks were too lightly armored, their Russian crews could not communicate with the Spanish troops, and in combat the tanks tended to run away from the supporting infantry and artillery. Pavlov argued that the new mechanized formations were too unwieldy to control, too vulnerable to antitank fire, and would have great difficulty penetrating enemy defenses in order to conduct a deep battle. The fact that Pavlov had been able to use only fifty tanks without any chance of surprise at the battle of Esquivas (29 October 1936) apparently did not dissuade him from generalizing.⁴⁹ In any event, many observers from other armies reached the same conclusions based on the limited experience in Spain.

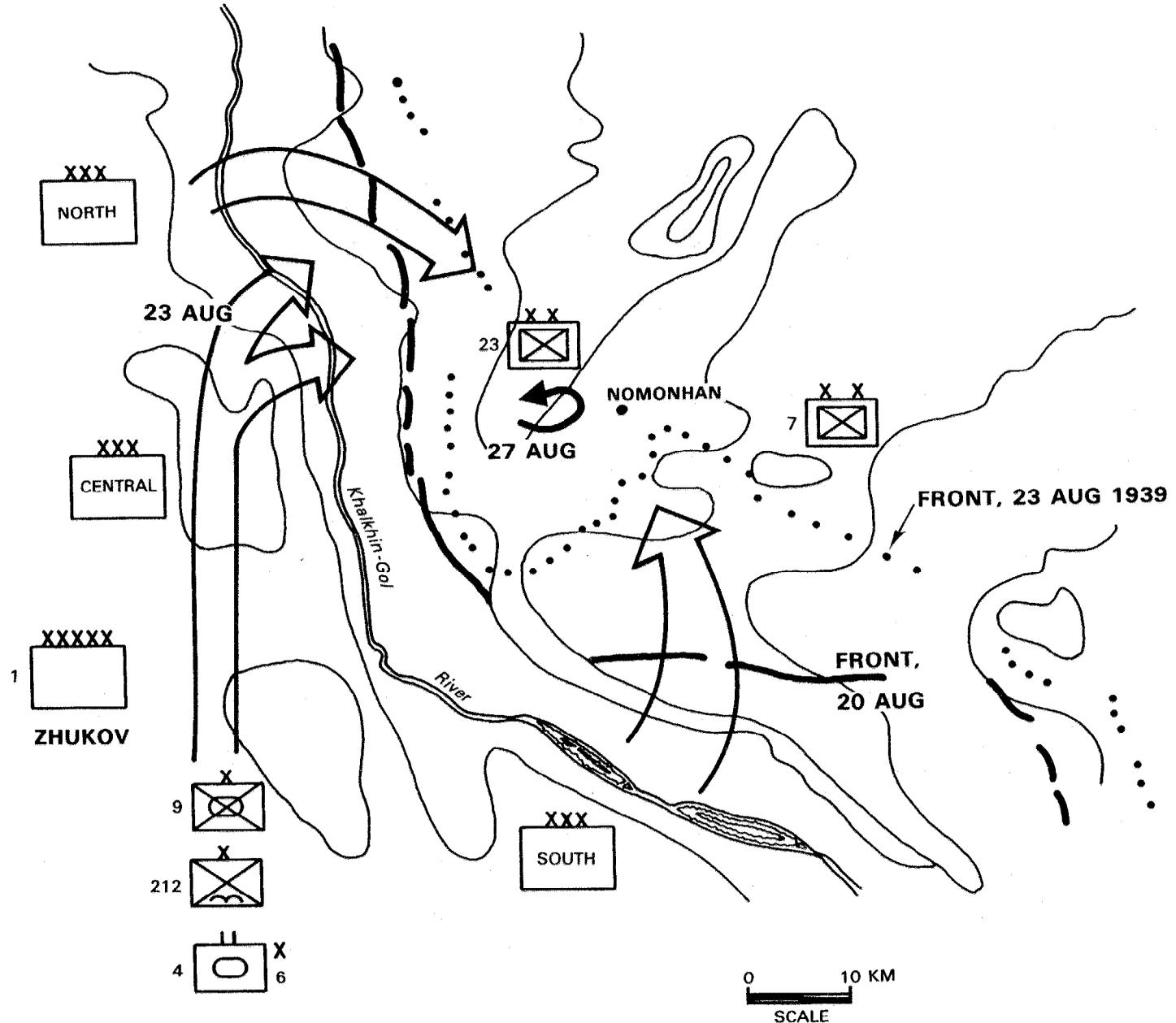
In July 1939, Gen. G.I. Kulik chaired a commission to review the question of tank force organization. With most of Tukhachevsky's followers dead or imprisoned, there were few advocates for large mechanized formations. The commission therefore directed the partial dismantling of such units, emphasizing the infantry-support role. The commission also created a new, more balanced organization, the motorized division of December 1939 (Figure 7). This continued support for the 1936 doctrine and force structure may have been in response to the

German armored success in Poland in September 1939, and the Soviet success that year against Japan (see below). Four of a planned fifteen motorized divisions were formed in early 1940, representing a better all-around organization than the tank corps they replaced.⁵⁰

In spite of this reorganization, the Red Army was a shambles, unable to occupy Poland effectively in 1939 or to defeat Finland rapidly in 1939-40. These battlefield failures prompted a series of reforms in organization, leadership, and tactics that slowly began to improve Soviet military ability. The only successful Soviet campaign of this period was in the undeclared war against Japan. Stalin was apparently so concerned about Japanese expansion in northeast Asia that he gave one of Tukhachevsky's most able students, Gen. Georgi Zhukov, a free hand in commanding the Soviet forces there. The Red Army in Siberia was among the last to be affected by Stalin's purges, and so, with the exception of some reserve component units, the training and command structure of these forces were still intact when hostilities with the Japanese Army erupted in the summer of 1939 on the Khalkin-Gol River of Manchuria (Map 4). The Japanese decided to fight the Soviets in this remote area on the border between Japanese-occupied Manchuria and Soviet-dominated Outer Mongolia, believing that the Soviets would be unable to concentrate and supply a major force there. To the surprise of the Japanese, the Soviets massed 469 light tanks, 426 other armored vehicles, 679 guns and mortars, and over 500 aircraft, all supplied by thousands of trucks. Zhukov organized a classic double envelopment between 20 and 31 August 1939. First, a series of Soviet probing attacks in the center fixed the Japanese defenders, and Soviet artillery concentrated against strongpoints found by these probes. Then the two Soviet flanks pressed forward, encircling the Japanese 23rd Infantry Division and part of the 7th Infantry Division. The Soviet attacks used tank and machine gun direct fire, as well as coordinated artillery fire, to protect their advancing infantry. In some cases, the infantry rode on the outside of armored cars, reducing the time needed to close with the enemy, but exposing both vehicles and riders to concentrated enemy fire. On the other hand, some Soviet commanders were unimaginative in executing Zhukov's plan, making repeated frontal attacks instead of bypassing Japanese resistance.⁵¹ Still, Khalkin-Gol provided an excellent trial of Soviet doctrine on the very eve of World War II. Zhukov and his subordinates naturally rose to prominence during that war.

United States

The U.S. Army, despite its unique division structure, was heavily under the influence of French tactical and staff doctrine in 1918. Of necessity, American officers had learned to do business in a manner compatible with the French units they dealt



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with daily. To some extent, therefore, the immediate postwar doctrine of the U.S. Army paralleled that of the French Army. As in France, the United States subordinated tanks to the infantry branch. Initial postwar regulations reflected the French view of combined arms so faithfully that in 1923 the War Department drafted a Provisional Manual of Tactics for Large Units that did not even mention the fact that it was a direct translation of the 1921 French Provisional Instructions.⁵² The same year, the revised version of the U.S. Field Service Regulations insisted that "No one arm wins battles. The combined employment of all arms is essential to success." In the next paragraph, however, it stated that the mission of the entire force "is that of the infantry."⁵³

Still, this rigid view of combined arms did not affect all American soldiers, nor did it last for a long period of time. As early as 1920, staff officers such as Brig. Gen. Fox Conner had decided that the requirements of trench warfare were inappropriate for operations on the American continent, the expected arena of future American wars. Conner asked Gen. John J. Pershing, the U.S. wartime commander in France, to discard the square division structure because it was too immobile and unwieldy for such operations. Pershing recommended that the infantry division be reorganized along the lines of European triangular divisions and that units needed only for specialized operations be pooled at the level of corps and field army.⁵⁴ These principles eventually produced a comprehensive review of the fundamental relationships between the different arms and services.

Despite a number of boards reviewing the American experience in World War I, the square division's organization changed only slightly during the 1920s. By 1925, American officer education was focused on mobile warfare, with trench warfare relegated to the status of a special operation. However, financial restrictions and the general peacetime neglect of the U.S. Army prevented major changes in equipment and organization until the mid-1930s. Then the army was able to use public works funds allocated to restart the depression economy as a means of achieving limited improvements in equipment. These included partial motorization of active and National Guard divisions and production of different carriages with pneumatic tires for existing artillery pieces. Such carriages allowed the artillery to be towed by motor vehicles and, in the case of the French-designed 75-mm gun, to be used in a limited anti-aircraft role.

In 1935, Gen. Malin Craig became Chief of Staff of the U.S. Army. Craig had apparently been influenced by Fox Conner and the other reformers of 1920, and he instigated a review of all combat

organization and tactics.⁵⁵ Craig specifically suggested development of a smaller, more mobile division using mechanical power to replace human power wherever possible. A General Staff board drew up a proposed division structure that totalled only 13,552 men and closely paralleled European divisions of the same period. From 1936 through 1939, the 2d U.S. Infantry Division conducted extensive tests of this concept, reviewing such matters as the amount of firepower and frontage that should be allocated per man and per unit, the proportion of artillery and transportation that should support the infantry, and the echelon (platoon, company, battalion, or regiment) at which different infantry weapons should be pooled. One of the driving forces behind these tests was Brig. Gen. Lesley J. McNair, who later designed and trained the Army Ground Forces of World War II.

The resulting organization of infantry was remarkably close to the Pershing-Conner ideas of 1920. In essence, the machine gun and other specialized heavy weapons were integrated into the infantry rifle organization at every level. To avoid an excessive span of control, each commander had a headquarters, three subordinate rifle units, plus a weapons unit--three rifle platoons and a heavy weapon platoon in each company, with three such companies plus a heavy weapons company in each battalion. In practice, commanders might shift companies from one battalion to another, or even move entire battalions between regiments, but doctrinally all units operated with three subordinate maneuver units.

Each echelon also had a combination of flat-trajectory and high-angle weapons. Although the infantry received greater firepower in terms of automatic weapons and mortars, this firepower was echeloned so that it did not impede the mobility of the parent infantry unit. Thus, for example, the infantry platoon had nothing heavier than the Browning Automatic Rifle (BAR), while the company had nothing heavier than the 60-mm mortar.⁵⁶ It should be noted that this dedication to mobility, when combined with a continued faith in the individual rifleman, meant that an American army platoon had less firepower than its European counterparts--the BAR had a much lower rate of fire than most light machine guns found in European squads. This deficiency was only partially corrected by the rapid-fire ability of the M1 rifle. Since American tactics were based on the premise of establishing a base of fire and then maneuvering a light force in conjunction with that base, this organization left U.S. infantry at a disadvantage.

The same principle of weapons pooling was continued throughout the triangular division. Light antitank guns, heavy mortars, and machine guns were relegated to the heavy weapons

company of each battalion. Specialized arms such as tanks, antiaircraft, and most antitank weapons were not authorized within the division, because McNair believed that such weapons should be held in a central mass and used only against a major enemy force. Similarly, the division received only one reconnaissance troop, with long-range reconnaissance being assigned to higher headquarters. The general result was an infantry force that was at once more mobile and more heavily armed than its predecessors, yet deficient compared to foreign armies. Its principal drawback, in addition to automatic weapons, was its limited capacity for antiaircraft and antitank defense. As remarked before, during the later 1930s heavy machine guns still seemed effective against aircraft and armored vehicles, so that these weapons, plus 37-mm antitank guns, appeared adequate for the triangular division. Once the German blitzkrieg demonstrated its psychological and physical effect on infantry, the U.S. Army realized that it had to add more antitank defenses.

The controversies about the triangular division tests included the proportions of engineers and artillery for the infantry component. The army was conditioned to regard the engineers only in their World War I role of road construction and limited fortification support. At one point, General Craig suggested eliminating all engineers from the division structure. In 1938, General McNair recommended an engineer company of 175 men, or 1.7 percent of the division, because he believed that only hasty road repair and limited roadblock construction would occur in the next war. The engineers had to campaign vigorously for their very existence in the division, arguing that an increasingly motorized and mechanized army had greater need for engineers to construct and reduce antitank defenses and other obstacles. Only the German use of combat engineers for such tasks in 1939-40 finally convinced the U.S. to retain an engineer battalion in each division.⁵⁷ Even this was a mixed blessing for the engineers, because they were frequently used as the division's infantry reserve force.

The 1935 division proposal had envisioned a division artillery consisting of three combined 75-mm gun/81-mm mortar battalions for direct support, with a 105-mm howitzer battalion for general support. All other artillery was to be nondivisional, attached as necessary. In actual testing, the artillery found that the 81-mm mortar was essentially an infantry weapon. In any event, McNair objected to this emphasis on dedicated support to the infantry, arguing that longer-range weapons with greater centralized control would lead to more flexible massed fires. No unit, he said, needed weapons whose

range exceeded the parent unit's area of operations. Ultimately, the decision was made to have three battalions of 75-mm guns, to be replaced by 105-mm howitzers when they were produced, plus 155-mm general support artillery. The June 1941 organization (Figure 8) represented the final step prior to American entry into the war.

The debate over artillery in the division organization occurred at the same time that the U.S. Army Field Artillery School was developing the next major step in infantry-artillery fire coordination, the ability to mass fires on targets of opportunity. During World War I, massed fires were normally the result of carefully planned artillery concentrations, in which known targets were predesignated on maps or overlays. If the infantry needed artillery fire on an unexpected target of opportunity, however, it was difficult to bring more than one battery to bear on such a target. To begin with, a battery forward observer had both to see the target and to communicate with his battery, which meant in practical terms that he had to keep in field telephone contact with the battery. This reliance on landline communications greatly restricted his ability to accompany the infantry in the advance, although some forward observers managed this feat. Even if the forward observer could adjust his own battery onto a target, he had no accurate way of guiding other batteries, unless the target's map location was known precisely.

Between 1929 and 1941, a series of instructors at the Field Artillery School gradually developed a means of concentrating any amount of available artillery fire on a target of opportunity.⁵⁸ One obvious step in this process was to have observers use new, more reliable radios instead of field telephones to communicate. More importantly, the gunnery instructors developed forward observer procedures and a firing chart that together would allow a battalion headquarters to record adjustments in the impact of artillery shells as viewed from the observer's location, instead of the battery location. Graphic firing tables compensated for differences in the locations of different batteries, and one artillery piece in each battalion was ultimately surveyed in relation to a common reference point for all artillery in that division area. The resulting fire direction centers (FDCs) could provide infantry units with an entire battalion, or even multiple battalions, of field artillery firing on a target that only one observer could see. By contrast, throughout World War II German artillerymen had to use well-known terrain features to adjust on a target of opportunity; massed fires remained extremely difficult. Fire direction centers gave the U.S. Army a new and unprecedented degree of infantry-artillery integration. It also encouraged the

U.S. to maintain large amounts of nondivisional artillery to reinforce divisions as needed.

The United States was not nearly so advanced in the development of armored and mechanized forces.⁵⁹ As in France, the supply of slow World War I tanks and the subordination of tanks to the infantry branch impeded the development of any role other than direct infantry support. Yet the British experiments of the later 1920s, plus the persistent efforts of a cavalry officer named Adna Chaffee Jr., led to a series of limited steps in mechanization. In 1928 and again in 1929, an ad hoc Experimental Armored Force (EAF) was organized at the Tank School in Fort Meade, Maryland. Two battalions of obsolescent tanks, a battalion of infantry in trucks, an armored car troop, a field artillery battalion, plus small elements of engineers, signals, medical, ammunition, chemical warfare, and maintenance, formed the EAF. Despite frequent mechanical breakdowns, the experiments aroused sufficient interest for a more permanent force to be established at Fort Eustis in 1930. The continuing economic depression, however, caused the Army to disband this unit a year later for lack of funds. The Infantry School at Fort Benning absorbed the Tank School and remaining infantry tank units.

As Chief of Staff from 1930 to 1935, Douglas MacArthur wanted to advance motorization and mechanization throughout the army, rather than confining them to one branch. Restricted army budgets made this impossible, but Chaffee did persuade MacArthur to conduct limited mechanized experiments with cavalry units, because cavalry's existence was threatened by its apparent obsolescence. By law, "tanks" belonged to the infantry branch, so the cavalry gradually bought a group of "combat cars," lightly armored and armed tanks that were often indistinguishable from the newer infantry "tanks." In 1932 a one-squadron mechanized cavalry regiment moved to Camp Knox, Kentucky, to be followed by another regiment in late 1936. These units were the nucleus of the 7th Cavalry Brigade (Mechanized). A series of early armor advocates commanded this brigade, including Adna Chaffee himself in 1938-40. However, this force was plagued by the same difficulties as mechanized cavalry in Europe. It was too lightly armed and armored and was viewed generally as a raiding or pursuit force in the cavalry tradition. Despite all of Chaffee's efforts, the other arms only cooperated with the brigade on periodic exercises. Not until January 1940, for example, was a mechanized engineer troop authorized for the 7th Brigade.⁶⁰ At about the same time, the 6th Infantry Regiment joined the 7th Brigade, and a Provisional Tank Brigade grew out of the infantry tank units at Fort Benning.

The German armored attack on France in May 1940 gave further impetus to mechanized experiments already conducted in U.S. Army maneuvers. To avoid branch prejudices, Chaffee convinced the War Department to create an "Armored Force" outside of the traditional arms. In consequence, in July 1940 the 7th Cavalry Brigade and the Provisional Tank Brigade became the nuclei for the first two armored divisions. These divisions, like the first organizations of the European powers, were excessively tank heavy. Each was authorized six battalions of light tanks and two battalions of medium tanks (approximately 400 tanks total), but only two battalions of armored infantry and three battalions of artillery. The majority of light tanks reflected the cavalry heritage of this division. Such a structure left inadequate infantry to support the tanks and too many lightly armored vehicles to fight the heavier German tanks. Considerably more production and development was needed before the lopsided American armored units became a cohesive mechanized force.

Finally, close air support was also lacking in the American combat team. Despite the efforts of a few aviators such as Frank Lackland, the U.S. Army Air Corps was preoccupied with strategic bombing to the neglect of close air support.⁶¹ As in France and Britain, American aviators argued that air power was best used in areas beyond the range of ground artillery. This apparently logical division of labor overlooked three aspects of ground combat: the psychological impact of close air attack, the necessity of massing all combat power to overcome the inherent advantages of the defender, and the need to achieve this mass rapidly in order to sustain mobile operations and deny the defender time to organize. Like Guderian, Chaffee hoped to use such techniques to avoid the delays and logistical buildup necessary for a deliberate, breakthrough attack. All three aspects argued in favor of close air support at the critical point, but in 1939-40 only the German Luftwaffe had made even limited preparations to provide such support.

The preceding discussion of five different armies appears to go in five different directions, and yet certain common threads are evident. First, anti-war sentiment, limited defense budgets, and similar restrictions hampered the development of new weapons and doctrine in every army except the pre-1937 Red Army. As a consequence, no nation was fully equipped with modern weapons when it entered World War II, although the Germans were several years ahead of their opponents and, therefore, had more experience and training with such weapons.

Second, even within the peacetime armies, the World War I traditions of infantry-artillery dominance delayed new developments designed to broaden the nature of the combined arms,

although the Red Army was again an exception until 1937. In the British, French, and American armies, mechanization developed in two divergent directions. Heavy, almost armor-pure formations supported conventional infantry attacks, while highly mobile but poorly armed and protected light forces performed cavalry functions. For the British, the demands of imperial policing further restricted any move towards development of large mechanized units. Still, even the Germans and Soviets diverted some armor to specialized cavalry and infantry-support roles. During the 1930s, professional soldiers gradually broke free of traditional, 1918 views about the role of various arms. The Germans had the advantage in these new developments, certainly after the purges had shattered the Red high command. Thanks to Guderian and Hitler, the Germans funneled more of their assets into fewer Panzer units than did their opponents, who tended to modernize slightly a much larger part of their armies, and who therefore had no force trained and equipped for mechanized combat in 1939-41.

Finally, the air power advocates of all nations retarded the development of close air support for ground operations. Even the Germans had only the embryo of an air-ground command and control system when the war began.

Had World War II come in 1936 or 1937, Tukhachevsky's developments in the Red Army probably would have triumphed despite problems with materiel and training. Had the war begun in 1942 or later, the British, French, and Americans would all have had time to experiment with and adjust their mechanized organizations and doctrine. Germany's military success in 1939-41 was therefore the product of a very transitory set of advantages. The Germans had produced equipment and fielded mechanized units in the mid-1930s, so that this equipment was still usable and the units were well organized and trained when war began in 1939. In addition, Germany had two advantages that the other powers lacked: a primitive but developing close air-support system, and a command and control network that allowed for much more rapid maneuver than any opponent could achieve.